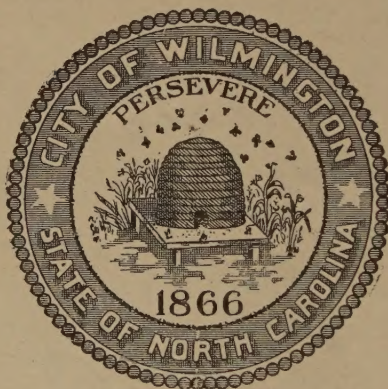


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THE NORTH CAROLINA GEOLOGICAL SURVEY

Economic Paper, No. 6.

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1901

BY

JOSEPH HYDE PRATT

MINERALOGIST



RALEIGH

E. M. UZZELL, PUBLIC PRINTER AND BINDER

1902

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N.C. Collection

N.C. Mines and Mineral Resources

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LETTER OF TRANSMITTAL.

RALEIGH, N. C., May 1st, 1902.

To His Excellency, HON. C. B. AYCOCK,

Governor of North Carolina.

SIR:—I have the honor to submit for publication, as the sixth of a series of economic papers, a report on the *mining industry* in North Carolina for 1901. Its publication is intended to meet inquiries that are constantly being received at this office for information concerning the condition of the mining industry and the different minerals that are being mined in the State. It takes up more in detail than the report of last year, descriptions of the occurrences of economic minerals in the State, and calls attention to those that are worthy of further investigation and that give promise of developing into remunerative properties.

Yours obediently,

J. A. HOLMES,
State Geologist.

MINING INDUSTRY IN NORTH CAROLINA DURING 1901.

INTRODUCTION.

The first year of the new century (1901) that has just closed has seen a decided gain in the mining industry of North Carolina. There has been an increased production of minerals and a progressive substantial development of mineral properties. The most notable features of the mining industry are the very extensive developments that are being carried on in the Person county and Ashe county copper belts; the increased demand for monazite; and the large increase in the production of kaolin and talc. Among the iron mines there has been a slight increase in the development of properties, but the production has been confined to one mine. In the gold fields there has been a steady advance in the manner in which new properties have been opened up, and old ones put into shape to become producers.

There are many natural advantages that are favorable to mining operations in North Carolina. The mining fields are all within easy distance of the large business centers; thus leaving New York at 4:30 P. M., North Carolina is reached early the next morning and by the same night nearly any mining camp in the State can be reached. Labor is cheap, although really skilled labor commands about the same price here as in other southeastern States, but is much less than corresponding labor in western mining camps. Climatic conditions permit of nearly continuous mining throughout the year. Most of the mines are in proximity to railroads and also centers of mining supplies, as Charlotte and Salisbury; and to timber for lumber and cordwood which can be obtained at a low cost. Another important advantage is the abundance of water-power that is available at many of the mining localities, which would make practicable the installation of electric power plants. While there have been some failures in

mining during 1901, there has been less speculative mining than for many years; and the mining and prospecting that is being carried on is along legitimate lines. That this is reacting favorably is apparent from the renewed interest that capitalists are now taking in North Carolina mining propositions, and the large amount of money that is being systematically spent in the development of mines and mineral properties.

Often, when occasions arise that increase the demand for a certain mineral; or trade conditions change so that new sources of supply are imperative; or new industries spring up that call for certain minerals for their manufacture, these minerals are found in large quantities where, in many cases, they were formerly supposed to be rare. North Carolina has furnished many of these, and when there is a demand for a new commercial mineral it is one of the first States that is looked to to furnish the supply. Every year minerals new to the State are being added to the list and frequently a new mineral species is discovered, thus constantly increasing the variety of minerals to be found within the Commonwealth.

It may be of some advantage as well as of interest to give here a list of the minerals that have been found in the State, and to indicate those that have a commercial value and of these, those that have been found in quantity in North Carolina. There are now 205 minerals that have been identified in North Carolina, some of which are new species that were first identified in this State, and these are indicated in the list below by the letter *a*.

LIST OF MINERALS FOUND IN NORTH CAROLINA.

- | | |
|---|---------------------------------------|
| 1. Actinolite (an Amphibole). | 10. <i>Anglesite</i> . |
| 2. <i>Albite</i> * (a Feldspar). | 11. Anorthite (a Feldspar). |
| 3. Allanite. | 12. Anthophyllite. |
| 4. <i>Almandite</i> .* | 13. <i>Anthracite Coal</i> . |
| 5. Altaite. | 14. <i>Antimony</i> . |
| 6. Alunogen. | 15. <i>Apatite</i> . |
| Amazon Stone (Var. <i>Microcline</i>). | 16. <i>Arsenopyrite</i> . |
| Amphibole (Group name). | 17. Arfvedsonite. |
| 7. Anatase. | 18. <i>Argentite</i> . |
| 8. <i>Andradite</i> .* | 19. Arragonite. |
| 9. Andesine (a Feldspar). | 20. <i>Asbestos</i> * (an Amphibole). |

21. Auerlite.^a
22. Augite (a Pyroxene).
23. Autunite.
24. Azurite.
25. Barite.*
26. Barnhardtite.^a
27. Beryl.*
28. Biotite.
29. Bismite.
30. Bismutite.
31. Bismuthinite.
32. Bituminous Coal.*
33. Bornite.*
34. Braunite.
35. Breunnerite.
36. Bronzite.
37. Brookite.
38. Calamine.
39. Calcite.
40. Cassiterite.
41. Cerargyrite.
42. Cerolite.
43. Cerussite.
44. Chabasite.
45. Chalcanthite.
46. Chalcedony.*
47. Chalcocite.*
48. Chalcopyrite.*
Chlorite (Group name).
49. Chloritoid.
50. Chromite.*
51. Chrysocolla.
52. Chrysolite (Olivine).
53. Chrysoprase.
Chrysotile* (Var. of Serpentine).
54. Columbite.
55. Copper.
56. Corundum.*
57. Covellite.
58. Crocidolite.
59. Crocoite.
60. Culsageeite.^a
61. Cuprite.
62. Cuprosheelite.
63. Cyanite.
64. Cyrtolite.
- Damourite (Var. of Muscovite).
65. Deweylite.
66. Diamond.
67. Diaspore.
68. Diopside (a Pyroxene).
69. Dolomite.
70. Dudleyite.^a
71. Dufrenite.
72. Edenite (an Amphibole).
73. Enstatite.
74. Epidote.
- Feldspar.* (Group name).
75. Fergusonite.
76. Fibrolite.
77. Fluorite.
- Fuchsite (Var. of Muscovite).
78. Gahnite.
79. Galena.
- Garnet* (Group name).
80. Garnierite.
81. Genthite.
82. Glauconite.
83. Gold.*
84. Goslarite.
85. Gothite.
86. Graphite.*
87. Gummite.*
88. Gypsum.
89. Halite.
90. Halloysite.
91. Hatchettolite.^a
92. Hausmanite.
93. Hematite.*
Hiddenite^a* (Var. of Spodumene).
94. Hisingerite.
95. Hornblende (an Amphibole).
- Hyalite (Var. of Opal).
96. Hydrofergusonite.
97. Hypertshene.
98. Ilmenite.
99. Iron (meteoric).
- Itacolumyte (Var. of Quartz).
100. Jefferisite.
- Kammererite (Var. Penninite).
101. Kaolinite* (Kaolin).
102. Kerrite.^a

103. Labradorite (a Feldspar).
104. Lazulite.
105. Leucopyrite.
106. **Lignite** (Brown coal).
107. *Limonite*.*
108. Linarite.
109. Lucasite.^a
110. Maconite.^a
111. *Magnesite*.
112. *Magnetite*.*
113. *Malachite*.
114. Marcasite.
115. Margarite.
116. Marmolite.
117. Martite.
118. Melaconite.
119. Melanterite.
120. *Microcline** (a Feldspar).
121. Mitchellite.^a
122. *Molybdenite*.
123. Molybdite.
124. *Monazite*.*
125. Montanite.
126. Montmorrillonite.
127. *Muscovite*.*
128. Naryagite.
129. *Niter*
130. Octahedrite.
131. *Oligoclase** (a Feldspar).
132. Olivenite.
133. *Orthoclase** (a Feldspar).
134. *Opal*.
135. Paragonite.
Pargasite (Var. of Hornblende).
136. Penninite.
137. Pharmacosiderite.
138. *Phlogopite*.
139. Phosphuranylite.^a
Picotite (Var. of Spinel).
140. Picrolite.
Pinite (Var. of Muscovite).
141. Pleonaste.
142. *Polyorase*.
143. Prochlorite.
144. *Psilomelane*.
145. Pseudomalachite.
146. *Pyrite*.*
147. Pyrochlore.
148. *Pyrolusite*.*
149. Pyromorphite.
150. *Pyrope*.*
151. *Pyrophyllite*.*
Pyroxene (Group name).
152. *Pyrrhotite*.
153. *Quartz*.*
154. Rhodochrosite.
155. *Rhodolite*.*^a
156. Rogersite.^a
Ruby Spinel (Var. of Spinel).
157. Rutherfordite.^a
158. *Rutile*.
159. *Samarskite*.*
160. Saponite.
161. *Sheelite*.
162. Schreibersite.
163. Scorodite.
164. Senarmontite (or Valentinite).
165. *Serpentine*.*
166. *Siderite*.*
167. *Silver*.*
168. Sillimanite.
169. Smaragdite (an Amphibole).
Soapstone* (Var. of Talc).
170. *Sphalerite*.
171. *Sperryllite*.
172. Spessartite.
173. *Spinel*.
174. *Spodumene*.
175. Staurolite.
Steatite (Var. of Talc).
176. *Stibnite*.
177. Stilbite.
178. Stolzite.
179. *Succinite* (amber).
180. *Sulphur*.
181. *Talc*.*
182. Tantalite.
183. *Tenorite*.
184. Tetrahedrite.
185. Tetradymite.
186. Thorite.
Thulite (Var. of Zoisite).

187. Titanite (Sphene).	197. Wad.
188. <i>Topaz</i> .	198. Wavellite.
189. Torbernite.	199. Wellsite. ^a
190. <i>Tourmaline</i> .	200. Willcoxite. ^a
191. Tremolite (an Amphibole).	201. <i>Wolframite</i> .
192. Troilite.	202. Xanthitane.
193. <i>Uraninite</i> .*	203. Xenotime.
194. Uranophane (Uranotil).	204. <i>Zircon</i> .*
195. Vermiculite.	205. Zoisite.
196. Vivianite.	

Of these 205 minerals, those in italics are of commercial value and of these, those marked with an asterisk have been found in sufficient quantity in North Carolina to warrant either mining or further developing them. It is not at all improbable but that in the course of time some of these other minerals will have a commercial value, and that large deposits will be found of those which are now known to have a commercial value but which have thus far been found but sparingly in North Carolina.

The close of the first year of the new century shows a most promising increase in the mineral production of the State, the total production being \$1,764,233.94 as compared with \$1,604,078 in 1900. All indications are that at the end of 1902 there will be a large increase in the mineral production over that of 1901. Many mining enterprises are being conducted on a larger scale than before and by the combining of some of the smaller mines under one management, they could be worked to better advantage. The condition of the mining industry in North Carolina at the beginning of 1902 and some idea of its outlook for the future are given in the following pages, which take up in detail the mining operations of the various minerals.

GOLD.*

The North Carolina gold deposits have been worked more or less continuously since 1799, which is the first authentic account of gold having been found in the State. Since that time there has been over \$22,000,000 worth of gold mined. Although this is a favorable record, yet at the present time the gold mining industry is not in a very

*See also Bulletin 10, N. C. Geol. Survey, On Gold Deposits of N. C.

active condition. The causes for this decline are the exhaustion in many mines of the free milling ores, and of the richer placer deposits; the methods employed in mining; and a lack of knowledge of the treatment of the sulphurets.

The area in which the gold deposits are known to occur is a broad one, embracing from 8,000 to 10,000 square miles of the middle and western counties. There are three types of occurrences of these ores, as follows: In quartz fissure veins, carrying either free gold, or gold-bearing sulphurets; impregnations of free gold and finely divided sulphurets in the country schists and slates; and the placer deposits.

There are in the neighborhood of 400 localities in the State that have have been mined for gold; but at the present time there are not over 15 mines that are being worked, principally in Cabarrus, Mecklenburg, Davidson, Stanly, Montgomery and Rowan counties. There have been a number of new gold properties opened up and developed during 1901, but the greater part of the work has been confined to old mines and properties, some of which have been quite extensively operated. While there has not been as much actual mining, as was expected, yet there has been a great deal of work done, the greater part of which has been systematic and valuable.

Improved methods and machinery are making it more possible from year to year to use ores that were formerly supposed to be of little value or of a too refractory nature to be economically worked. Then again, there has been too much of a tendency to operate the mines on too small a basis, and it will be found that if a number of these gold deposits are operated under one management, they will make a profitable investment, while they are unprofitable when worked separately. The establishment of a custom smelter at Charlotte will be a strong incentive to more active mining in Mecklenburg and neighboring counties. This smelter is being erected by the United States Smelting-Refining Company of New York. They will obtain a portion of their supply of ore from their own mines, but expect, however, to draw the larger part of the ore from other mines in the vicinity. This should be the means of the re-opening of many of the smaller mines and properties which are not capable of supporting a smelter of their own.

TREATMENT OF SULPHURET ORES.

In the treatment of the Carolina sulphuret ores, consideration must be taken of the rocks in which they occur. A large proportion of these ores occur in a rock consisting essentially of argillaceous schists and slates that are interlaminated with thin layers or lenses of quartz. Some of these rocks were igneous in origin, but have been altered to their present condition. There are bands of these rocks that are impregnated with free gold and finely divided gold-bearing sulphurets. The metallic contents are usually heavier along the cleavage planes of the schists and where the free gold exists it is often in a very finely divided and flaky condition. On account of the fineness of the gold and the slimy condition of the crushed ore, there is considerable difficulty encountered in saving the gold. A portion of the gold can be saved by amalgamation, but the tailings from the plates must be treated either by the chlorination or cyanide process. When the ore is wholly or partially in the form of sulphides it must be roasted in order to free the gold before it can be treated by either of these processes.

In regard to the cost of roasting these sulphide ores of the Southern Appalachian region, the only figures available are those of Mr. Thies, superintendent of the Haile gold mine, Lancaster county, South Carolina,* and "it is evident from a perusal of his figures that the cost per ton can be considerably reduced by the use of McDougall or Herreshoff roasters. In Montana, where labor is higher and fuel is at least double what it is in the South, the cost for this character of work would not exceed 60c. per ton. Using the improved machinery now in use throughout the West and having the advantage of the low prices prevailing in the South, the cost should not exceed 50c. per ton.

"In reports by many eminent mining engineers, made during the past 20 years, the gold deposits of the South have been quite conclusively shown to contain an abundance of low-grade ore. The question has not been the amount of ore, but as to the economy of treatment. Within a radius of 20 miles of Salisbury, North Carolina, there are at least two dozen mines of unquestioned merit, not one of

*Eng. and Min. Jour., Oct., 1901.

which is in active operation to-day. It is quite evident then that the field is a large one, and a promising one for the introduction of a cheap process. The success of the chlorination process of Mr. Thies gives assurance that the cyanide process, when adapted to these ores, will be equally successful, and as it is relatively cheaper there is no question as to a choice between the two methods; the cost of dead roasting will be the same in both cases. The cyanide plant, however, will, it is believed, cost less to build, less to operate, and the cost for chemicals will be less. If the ores contain oxides or carbonates of copper, chlorination may be necessary. Where the copper occurs as a sulphide, there is no reason why the cyanide process cannot be used. The successful plants that have treated the ores by chlorination recovered on a \$4 ore, \$1.30 on the plates, \$1.80 in concentrates, and the tailings carry 90c. The concentrates treated by chlorination yielded an extraction of 94 per cent., so that the total extraction of the assay value of the ore is only 75 per cent.

"In order to treat such ores economically a plant should have a capacity of not less than 50 tons per day. A roaster to successfully handle that amount of ore per day will cost not less than \$10,000 when erected and ready for operation; the necessary cyanide vats, agitators, etc., will cost in the neighborhood of \$1,000 or \$2,000 more, and a working fund of \$10,000 should be allowed for mine development."*

Judging from the treatment of the slimy ores in various mills in Montana, the cost of mining and milling these ores should not exceed \$2 per ton; of course, tailings could be treated much cheaper. A prominent cyanide man, after visiting the Howie mine and other deposits in North Carolina and Georgia, wrote,† "that he knows of no more promising field in the United States for the extension of the cyanide process; that it possesses so many decided advantages over other sections that those who now take advantage of the situation and the low valuation at which the properties are held are certain to be richly rewarded. With the selection of a property worthy of a good plant and the exercise of the same business prudence and sagacity

*W. H. Weed, Eng. and Min. Jour., Oct. 19, 1901.

†Eng. and Min. Jour., Oct. 19, 1901.

in operating it that would be needed in other lines of industry, one is certain to be remunerated to an extent far beyond what one could hope for from any other merchantile investment."

LOCALITIES.

There has been but little work done in 1901 in what is called the Eastern Carolina gold belt, which covers an area of about 300 square miles in Warren, Halifax, Franklin and Nash counties, and extends in a northwesterly direction from the Thomas mine, $1\frac{1}{2}$ miles northeast of Ransom's Bridge, to and across the Tar river. Among the mines of this belt are the Thomas, Kearney, Taylor, Mann, Davis, Nick-Arrington, Mann-Arrington and Portis, the two latter being the most important. The principal work was done on the properties in the vicinity of the Portis mine, Nash county, where there has been some sluicing of the placer deposits and also on the Davis property.

The principal mining district of the Carolina belt is in the vicinity of Gold Hill, Rowan county. It is situated about 14 miles southeast of Salisbury in the southeast corner of Rowan county and extending into Cabarrus county on the south, and Stanly county on the east. The country rocks are chloritic and argillaceous schists, striking N. 25° to 30° E. and dipping 75° to 85° N. W. A diabase dike cuts the schists near the village of Gold Hill. The ore bodies consist of certain portions or bands in the schists that are impregnated with auriferous pyrite and of imperfectly conformable lenticular veins and stringers of quartz. There are six well defined approximately parallel veins in this district, known as the Randolph, Barnhardt, Honeycut, Standard, Trautman and McMakin. The principal work being done in this district for gold is by the Whitney Reduction Company, who are operating at and near the old McMakin mine. They have developed their mine by three shafts, the deepest one being about 600 feet, with cross-cuts between them. A well formed ore body has been blocked out that assays very favorably. In connection with their mining this company are developing the water-power at the Narrows of the Yadkin river and will erect their stamp-mill at this point. The Gold Hill Copper

Company expect to begin work at the Barnhardt mine during the coming year. The Union Copper Mining Company are mining principally for copper, but obtain more or less gold and silver as by-products. See page 20.

In Montgomery county one of the most noted mines is the Russell, which is about 3 miles northeast from Eldorado, and but a short distance from the Randolph county line. The country rocks are argillaceous slates, both of soft and silicified types. In part at least these slates are sedimentary and have a variable strike and dip. The ore beds consist of parallel belts in the slates impregnated with iron sulphurets (pyrite), and free gold together with some quartz stringers. The principal work at this mine consists of a big cut about 300 feet long by 150 feet wide and 60 feet deep. On the eastern edge of this cut is a shaft 150 feet deep, from the bottom of which the ore has been stoped upward. This mine is one of considerable promise and as far as can be determined contains low grade ore in quantity.

Some of the other principal mines and properties in this county are the San Christian, Appalachian (or Cogging), Morris Mountain, Riggon, Hill, Steel, Saunders, Marratock, Beavers Dam and Buck Mountain.

The Reed mine in Cabarrus county is about 11 miles southeast of Concord and is of interest as being the site of the first discovery of gold in North Carolina. In 1799 a 17-pound nugget was found and in 1803 one weighing 28 pounds. The placer deposits of the Reed mine have been very vigorously worked in former years and a considerable quantity of gold has been found. There are a number of other promising gold properties in this county, among which are the Nugget, Rock River, Buffalo, Phoenix, Furness, Tucker and Pioneer Mills mines, some of which have been more or less worked and developed during the past year.

Mecklenburg has been one of the most important and active counties in gold mining of any in the State. The mines are distributed over almost the entire county, with Charlotte as a center. The more important mines are the Davidson Hill (one mile west of Charlotte), Saint Catherine, Rudisil and Clark ($2\frac{1}{2}$ miles west of Charlotte), Palmer, Howe and Parks (1 mile northeast of Charlotte), Brawley

(4 miles west of Charlotte), Arlington (6 miles west of Charlotte), Capps, McGinn and Alexander (8 miles northwest of Charlotte), Dunn (7 miles northwest of Charlotte), Ferris and Ray (8 miles southeast of Charlotte), and Surface Hill (10 miles east of Charlotte).

The Rudisil mine, which is 1 mile south of Charlotte, is perhaps the best known. In the upper part of the mine the rock is a silicified, chloritic and argillaceous slate. At a depth of 200 feet this gives place to a crystalline eruptive rock. The ore bed consists of two parallel veins, close together and separated by a slate which varies in thickness from 2 to 6 feet. The maximum depth to which the mine has been worked is 300 feet. The mine carries very rich but highly sulphureted ores, and thus far but little attempt has been made at concentration or treatment of these sulphurets. Many of these mines will become producers when the custom smelter is able to handle their ores.

In Gaston county the principal mines are the Oliver and Farrar, which are about 12 miles northwest of Charlotte, the former of which is reported to have been worked by one of the early German settlers before the Revolutionary War; the Duffie, McLean, Long Creek and King's Mountain (or Catawba).

The King's Mountain (or Catawba) mine is situated about $1\frac{1}{2}$ miles south of King's Mountain, a station on the Southern Railway, in the southwest corner of the county. The country rock is mica schist intercollated with lenticular layers of siliceous magnesian limestone. The ore beds are large lenticular chimneys or shoots of this limestone containing auriferous quartz and sulphurets. Five of these chimneys or lenses have been opened in this mine. The length of these lenses reach about 100 feet and in thickness they are about 20 feet, being separated from each other by the black graphitic slate. The mine has been worked to a depth of 320 feet.

The principal mining that has been done in the South Mountain gold region has been the hydraulicing and sluicing of the extensive placer deposits which are found in Burke, McDowell and Rutherford counties, and it has only been within the last few years that any attempt has been made to work the quartz veins. Many of the gold-

bearing quartz veins are too narrow to justify any deep mining, but there are some that have been found on a much larger scale that give promise of making profitable mines. The principal work now being done on these veins is a section 6 and 12 miles north of Morganton, where two types of gold deposits have been encountered, one in which the gold occurs in the quartz veins and the other where it occurs in bands of the country rock, either in the form of free gold or finely divided sulphurets. This district is perhaps attracting as much attention as any other at the present time and has within the past two years furnished some splendid gold ore during the development work. The principal mines in this South Mountain district are the Miller, Scott Hill, Pack's Hill, and Baker mines in Caldwell county; the Mill's property, Hancock, Hercules and Martha mines in Burke county; Cain Creek, Brackettown, Huntsville and Vein in McDowell county; and the Golden Valley in Rutherford county.

There has been a little gold mining in Cleveland county and in the vicinity of Columbus, Polk county.

West of the Blue Ridge there has been but little mining carried on for gold, and it has been principally the sluicing of the gravels in Cherokee county.

The total production of gold in North Carolina for 1901 was \$60,410.71 (coining value) as compared with \$44,653 in 1900. This is an increase of \$15,757.71, which indicates the advance that is being made in gold mining in the State. In the table below are given the production of gold and silver by years from 1882 to 1901.

GOLD AND SILVER PRODUCTION IN NORTH
CAROLINA FROM 1882 TO 1901.*

YEAR.	GOLD.	SILVER.
1882-----	\$ 190,000	\$ 25,000
1883-----	167,000	3,000
1884-----	157,000	3,500
1885-----	152,000	3,000
1886-----	175,000	3,000
1887-----	225,000	5,000
1888-----	136,000	3,500
1889-----	145,000	3,878
1890-----	118,500	7,757
1891-----	95,000	6,465
1892-----	78,560	12,671
1893-----	53,600	17,325
1894-----	46,594	455
1895-----	54,200	520
1896-----	44,300	646
1897-----	34,600	388
1898-----	84,000	905
1899-----	34,500	388
1900-----	44,653	15,986
1901-----	60,410	34,023

While gold mining is at the present time but a small industry in North Carolina, when its production is considered, it is of considerable magnitude when the working capital invested in gold mines and properties is taken into consideration. The work that is now being carried on will result in the mines again becoming producers of gold in larger quantity than for the past twenty years.

SILVER.

There are mines in North Carolina that have been operated during 1901 exclusively for silver; but more or less silver is obtained in nearly all of the gold and copper mines, especially the latter. The copper mines at Gold Hill and in the Blue Wing district have produced most of the silver.

The principal silver mines are the Silver Hill, located 7 miles southeast of Lexington, Davidson county, and the Silver Valley, 5 miles northeast of the Silver Hill. These two mines have attracted a great deal of attention on account of the apparent richness of their

*Coining values are given.

ores, which are a complex mixture of galena, pyrite, sphalerite, chalcopyrite and quartz. The galena is rich in silver and near the upper surface of the Silver Hill, rich bunches of native silver were found, with the oxidized products of the primary sulphides. As the mining was carried deeper the unaltered sulphides were encountered and as the percentage of sphalerite (zinc blende) was high, mining became unprofitable. Pockets of pyrite were encountered that assayed over \$200 in gold, while other portions of the pyrite only showed the presence of a trace of gold. Ores of this type are receiving the attention of metallurgists and it is not at all improbable but that these ores will in time be able to be worked profitably, if they occur in sufficient quantity.

The production of silver in 1901 was over twice that of the year before and amounted to \$34,023.64 as compared with \$15,986 in 1900, an increase of \$18,037.64. This is the largest production that has been made for over 20 years. This large increase is partly due to the metal obtained from the copper ore of the Union copper mine at Gold Hill, and the larger production of copper ores in the Blue Wing district which contain some silver.

COPPER.

There has been a very material increase in the development and mining of the copper deposits of the State during 1901. The most important change in the copper situation is the addition to the list of producers of the mines of the Union Copper Mining Company at Gold Hill, Rowan county. The production has not only increased, but a number of mines have been thoroughly equipped and will become producers during 1902. Transportation facilities are greatly improved in the Blue Wing district and it is expected that the Ashe county deposits will soon have railroad connections.

The copper deposits of the State are for the most part in three distinct districts: the Virgilina or Blue Wing, which extends across Halifax county, Virginia, and Person and Granville counties, North Carolina; the Gold Hill of Rowan and Cabarrus counties; and the Ore Knob of Ashe county. Of these the first district has been the scene of the most development and the largest production.

OCCURRENCE.

*Virgilina District.**—The Virgilina or Blue Wing district consists of an area 20 miles in length and 3 miles or more in width; the mines for the most part being located on a rather flat-topped ridge rising 100 to 200 feet above the level of the surrounding valley. The country rock of this area is mainly what is known locally as greenstone or slate, which varies in color from dark green to grayish black. It is in fact an igneous rock of an andesite type, which has been crushed and metamorphosed. The fissures formed have been filled with metallic sulphides and gangue and are the veins that are now being worked and prospected. These fissure veins are dipping uniformly toward the east and have a strike nearly north and south (the general strike of the rocks being nearly 15 degrees east), and are approximately parallel to each other. They are sometimes cutting across the country rock and at other times are parallel to its schistosity. They vary in width from 2 to 15 feet, but the general average of those that are being most extensively worked are from 5 to 6 feet wide. Alteration of these ore deposits has extended to a depth of 25 to 40 feet and in some of the openings considerable malachite (green copper carbonate) is obtained. This alteration has not resulted in the formation of gossan, as this is usually understood, and the veins are comparatively firm and solid from the surface. There is some azurite (blue carbonate of copper) and cuprite (red oxide of copper) found in this zone of oxidation products and also rarely a little native copper. As the sulphide ores are encountered they are found to consist for the most part of chalcocite (gray copper or copper glance) and bornite (peacock copper). A very little chalcopyrite (copper pyrites or yellow copper) has been found along the western limits of the copper area. The gangue consists principally of quartz with some epidote, hematite and sparingly calcite. Gold and silver are also found in these ores in limited amount. The chalcocite ores are for the most part confined to the deposits in Person county and the bornite ores to those in Granville.

These veins are not found with a uniform width, but are all lenticular, although the largest veins have a continuous outcrop for a

*Am. Inst. Min. Eng.; Eng. and Min. Jour.

mile or more, and the underground workings show the vein to be continuous. They are, however, lenticular in form, widening and pinching both vertically and horizontally. This is the more noticeable in the smaller veins where the lenses of ore and quartz are connected with each other by simply a thin seam of quartz, which sometimes is lacking so that the vein has the appearance of giving out. These have been formed in part by the simple irregular fracturing of the metamorphosed schists, with a subsequent faulting, amounting to but a very few feet, which have produced the lenticular spaces that are now filled with quartz and ore, and calcite and ore. In some instances the faulting was complex and the result is a banded structure in the ore deposits, there being a succession of small seams or plates of the schist in the quartz gangue.

The most prominent mine of the district is the Holloway, 4 miles southwest of Virgilina, Va., on a spur of the Southern Railroad, and is owned by W. E. C. Eustis of Boston, Massachusetts. This is the most extensively developed mine in the district, and, while it represents a private enterprise, it is one of the most successful mining plants in the State. The mine has been worked to a depth of about 400 feet and the output shipped to a smelter at Norfolk, Virginia. The mine has been developed by four levels which have been run both north and south of the shaft for 100 feet at depths of 75, 150, 200 and 300 feet respectively. This work has shown the vein to vary greatly in width, being from 3 feet to about 100, and also illustrates the lenticular structure of the veins of this district, already referred to. The general trend of this Holloway vein is N. 15° to 20° E. With the present equipment of the mine, the output is about 50 tons of ore per day which is concentrated by hand-picking and cobbing to about one-half, which is shipped, the remainder being piled up awaiting some other means of concentration. This ore, which is more or less siliceous, is used to advantage at the smelter for fluxing with other ores low in silica.

The Blue Wing mine, formerly owned by the Boston and Carolina Copper Mining Company, and now controlled by Mr. John T. Williams of New York, is two miles south of Virgilina and was one of the first mines in this district to be developed. The mine is being

thoroughly equipped and put in shape for shipping high grade concentrates. The ore deposit differs materially from the others of the district and is a splendid example of the complex fissure vein referred to above. The mine has been developed by means of a shaft that is about 180 feet deep with drifts running from the 100 and 150-foot levels. At the 100-foot level the drift extends 348 feet north and 115 feet south of the shaft and shows the vein to be nearly constant, 3 feet in width. From this level to the surface the ore has been pretty thoroughly stoped out. The ore consists of bornite in a gangue of quartz and calcite.

The mines of the Person Consolidated Copper and Gold Mining Company, 8 miles south of Virgilina, are on the same vein as the Holloway, but near the southern end of the belt. The two principal mines of the company are the Yancey and Durgy, the former being one of the oldest mines of the district. Several thousand tons of ore are on the dumps that was taken out during the development work of last year. The company are preparing to erect a concentrating mill of 50 to 75 tons capacity and it is confidently expected that copper concentrates will begin to be shipped during 1902.

The Arringdale mine is 7 miles a little west of south of Virgilina and the Morong $3\frac{1}{2}$ miles south. Both of these mines are being developed by means of shafts and drifts, and are giving very encouraging results. Other mines that are being developed in the district are the Copper World, Warlick and Tingen mines. This district has now very much the appearance of a permanent and prosperous mining camp. All these ores contain more or less silver.

Gold Hill District.—The Gold Hill district is 14 miles southeast of Salisbury, beginning in the southeast corner of Rowan county and extending over into Cabarrus, a distance of 12 miles or more. The country rocks are chloritic and argillaceous schists and slates, striking about N. 25° to 30° E. and dipping 75° to 80° N. W. On the west of these schists there is an intrusive mass of granite and on the east metamorphosed dioritic rocks. The ore bodies consist of certain portions or bands of the schists or slates that are impregnated with auriferous pyrite and chalcopyrite and of imperfectly conformable lenticular lenses and stringers of quartz con-

taining these sulphides. These have in some cases been successfully worked for gold. The principal mine in this district is that of the Union Copper Company, who have thoroughly equipped their mine with all modern machinery for mining and hoisting the ore and have erected a large concentrating plant and smelter. The mine is about 14 miles southeast of Salisbury and three miles from Gold Hill depot, which is on the Southern Railway, but is connected by a spur with this line. There has been expended in the neighborhood of \$1,000,000 in the development of this property and the erection of buildings, etc., and this mine has become during 1901 one of the producers of copper.

The ore deposit has been developed by means of 12 shafts of varying depths, the deepest one being 800 feet. The ore consists principally of chalcopyrite, with occasionally a little bornite and pyrite, in a gangue of quartz. The mine is being worked by means of a vertical shaft 520 feet deep which is connected with a 430-foot inclined shaft; and by two separate vertical shafts, one 305 feet deep and the other 225 deep. Besides these working shafts there are 8 shafts ranging from 150 to 200 feet that were sunk during the development of the mine. The ore carries, besides copper, considerable values in gold and silver. The ore, as it comes from the mine, is sorted and the lower grades crushed and rolled and then concentrated. The concentrates, together with the selected ore, are roasted and then smelted to a matte containing 50 per cent. of copper and the gold and silver. This matte is shipped north for refinement.

Another mine in the Gold Hill district or belt is the Cruse mine, which is in Cabarrus county, about 10 miles northeast from Concord, the county-seat, and 12 miles nearly south from Gold Hill. Concord is the nearest railroad station. The ore occurs in a series of quartz lenses, having a width of from 1 to 3 feet and dipping about 55° to the east, but pitching a little toward the northwest. These lenses all have fairly sharp boundaries and in some cases are entirely separated from each other, while at other times they are connected by thin stringers of quartz. Their general strike is N. 35° W. and they can be traced almost continuously for about 600 feet. The vein has been developed by means of three shafts, 140

feet, 40 feet and 35 feet respectively in depth and by a number of small pits. The 140-foot shaft was in ore the whole distance, the vein varying in width from 15 to 30 inches. At a depth of 75 feet a drift was run 20 feet to the southeast, which showed the vein to practically pinch out in that direction. At the bottom of the shaft another drift was run to the southeast, which also showed the vein to nearly pinch out. Toward the northwest, however, as far as the work has been continued, which was 15 or 20 feet, the vein holds its own width. Hugging the foot wall at the bottom of the shaft was a seam of nearly pure chalcopyrite from 3 to 4 inches in width and this has been nearly continuous throughout the whole depth of the shaft. The rest of the vein had the chalcopyrite scattered sparingly through it in small bunches and particles. The other vein minerals were siderite (iron carbonate), which occurred in considerable quantity, hematite and pyrite in a gangue of quartz. Particles of chalcopyrite were also observed impregnating the country rock in some places for a distance of 7 feet from the vein. For a few feet each side of the vein, the wall rock is more or less impregnated with small seams and stringers of quartz that are apparently following the schistosity. The other two shafts encountered similar lenses of ore.

There are a number of other copper mines and properties in the vicinity of Gold Hill and Salisbury, as the Conrad Hill mine, 6 miles southeast of Lexington; the Gold Knob, 9 miles, and the Reimer, 6 miles southeast of Salisbury on the Yadkin river; and the Bullion, one-half a mile east of the Reimer. These properties should be able to be worked, if favorable railroad rates can be obtained for shipping their ore to the smelter of the Union Copper Company at Gold Hill. Many of these ores carry good values in gold and silver.

Ore Knob District.—In the Ore Knob district the principal mines are the Elk Creek, Copper Knob, and Ore Knob. Of these the Ore Knob mine was successfully worked as long as the oxidized products lasted. This Ore Knob mine is situated near New river, Ashe county. The ore deposit is a fissure vein with a strike N. 60° E., cutting the gneisses and mica schists comprising the country rock. The vein is from 6 to 14 feet wide and has been altered to a depth of about 40 to 70 feet. A strong iron goasan is encountered, be-

neath which, and between it and the sulphides, is an iron-black, friable and crystalline ore, carrying as high as 36 per cent. of copper. This ore is from 20 to 30 feet deep when the sulphide ores were encountered, which consisted of chalcopyrite with magnetite, pyrrhotite, and pyrite in quartz. This property is now being developed by the Garretson Southern Furnace Company, who are erecting a smelter and reduction works and expect to become producers of copper during 1902. The property has been developed by means of 8 shafts aggregating 854 feet and by 1,276 feet of levels. It has been estimated by the company that they have 150,000 tons of a 2 per cent. ore lying on the dumps.

The Peach Bottom Copper Company are developing the Elk Creek or Elk Knob mine on Elk creek, Alleghany county, by means of two shafts, one 140 feet and the other 170 feet in depth. The ore deposits are similar to those of Ore Knob and the work that has been done in this district shows ores to be in quantity, but of low grade.

In Jackson county there has been some development work carried on by the Cullowhee Copper Company at Forest Hill, near Cullowhee. In Swain county the Everett Mining Company has done some extensive development work on the copper property at Hazel creek near Medlin, and are erecting a smelter. Sufficient work has not as yet been done at either of these properties to actually determine their value. The ores are chalcopyrite. In Crab Orchard township, Mecklenburg county, the Vista Copper mine is being developed with some success. In Chatham county, about 2 miles southeast of Harpers Cross Roads on the Nat Phillips farm, some prospecting and development work has been done in 1901. One shaft 80 feet deep has been sunk which encountered a 12-inch seam of chalcocite (gray copper) ore at the surface which widened to over 3 feet at the bottom.

The custom smelter of the Union Copper Company at Gold Hill and the proposed one of the Blue Wing district will be of material advantage to the development of copper properties in their respective vicinities. With the price of copper at 12 cents per pound,

as it was at the beginning of 1902, there must be the more favorable conditions for mining and smelting of the ore; but even at this price, copper mining should be a good, profitable industry in the State. This reduction in price of copper does not mean a less demand, for this is constantly increasing, but with the increased number of producing mines and the fact that a number of the large users of copper are also now miners of this metal, it is not at all improbable but that the price will remain in the neighborhood of 12 cents per pound for some time to come.

During 1901 there were 10,398 tons of copper ore mined which were valued at \$76,900 as compared with 6,948 tons valued at \$41,600 in 1900. This is a decided increase in the production and is largely due to the Gold Hill district. Considering the amount of substantial work that is being done at the different copper mines, the production should be greatly increased in 1902.

IRON.*

The iron ores are very widely distributed over the State and include magnetite (the magnetic oxide of iron), hematite (the red oxide), limonite (the yellow oxide), and bog iron ores. Siderite or spathic iron occurs sparingly at a number of iron mines.

On account of the low prices of iron, many points have to be carefully considered regarding the ore in order to determine whether it can be profitably mined; and these are its chemical composition, mechanical structure, proximity to a supply of fuel, flux and water, and relation of the cost to the market price.

The first is by far the most important, for the first thing to determine is what percentage of iron the ore will carry, and how free it is from the injurious elements, sulphur, phosphorous, and titanium. There are a number of minerals that contain a high percentage of iron that will not make profitable iron ores, and very high percentage of iron in a mineral deposit does not necessarily mean a good iron ore. Many attempts have been made to use the titaniferous iron ores, but they have resulted in complete failure and loss. The titaniferous acid of the ore passes into the slag, making it very difficult of fusion, and 1 per cent. of titaniferous acid in the ore will condemn it. Sulphur is injurious

*See also Bulletin 1, 1893, N. C. Geol. Survey, Iron ores of N. C.

in an ore, for it cannot all be eliminated from the pig-iron, and renders it red-short, that is, brittle when hot; and phosphorous goes partially into the pig-iron, making it cold-short, that is, brittle when cold. Nearly all of the iron ores in North Carolina are low in sulphur, while those carrying titanium are usually confined to the magnetic ores.

The mechanical structure of the ore is also important, for the value of the iron increases or decreases according to the amount of gangue removed in mining the ore, and also the amount of cleaning that is necessary before the iron is ready for smelting, and the amount of foreign material that has to pass through the furnace. It is often of serious importance to determine whether it is cheaper to smelt the ore where it is mined or transport it to a furnace erected near the source of fuel and flux.

The history of iron mining in North Carolina dates back to as early as 1729, when small shipments of iron were made to England. The ore first mined was probably the bog ores near the coast. Mining for iron almost kept pace with the settlement of the western portion of the State. The remains of the old workings are still visible, but they do not indicate that because they have been worked there is a quantity of ore, or because they have been closed, the ore gave out. They would all have to be examined to prove them one way or the other.

Some of the principal iron localities are: The magnetite ores of Granville, Stokes, Surry, Catawba, Ashe and Mitchell counties; the limonite ores of Chatham, Gaston and Cherokee counties; and the hematite ores of Granville county, these being confined principally to the Piedmont Plateau and Mountain regions. Geologically, the magnetites and hematites are confined almost exclusively to the crystalline rocks. Some limonites are also found in these rocks as well as in the Ocoee formation of Madison and Cherokee counties. Limonite ores (bog-iron ores) are also found in the more recent formations of the Coastal Plain region.

The most noted iron mine in the State is the magnetite iron mine at Cranberry, Mitchell county, which is at the terminus of the East Tennessee and Western North Carolina Railroad. The ore body consists of an immense lens of magnetite that has associated with it

hornblende, pyroxene, epidote, quartz, feldspar, calcite, garnet, zircon, allanite, serpentine, etc., in varying proportions. The ore is distributed in irregular masses through the gangue and at times intimately associated with the same in thin bands. The thickness and extent of these bands are variable, from a few inches to more than fifty feet.

Nearly all the iron produced in 1901 was from this mine, and amounted to 2,578 tons valued at \$4,997, as compared with a production of 21,000 tons in 1900 valued at \$42,000. The Cranberry mine was not operated for the greater part of the year, the time being spent in development work and improvements to the plant. It is expected that in 1902 there will be a constant output per month that will make the total production for the year greater than that of 1900. The other mine producing iron in 1901 was the Potato creek mine, located in the Piney Creek district, Alleghany county, and contains magnetic ore.

The large iron deposits in Ashe county are reported to have been purchased by the Pennsylvania Iron Company, who contemplate beginning extensive operations in the near future.

The shutting down of the large blast furnace of the Empire Steel and Iron Company at Greensboro has been the cause of the closing down of the mines in the eastern and central part of the State. It is reported on good authority that this furnace will again be in operation before the end of 1902.

While at the present time the iron ores of the State are adding but little to its wealth, yet they do represent reserved sources of wealth that will in time be available. The competition with the Lake Superior iron ores that has effectually closed the North Carolina mines is not permanent, for their deposits are limited in extent, and unless new sources of supply are found in the immediate vicinity, other known iron ores will become available.

MANGANESE.

While there has been but a few sample car loads of manganese ore shipped from the State, there has been considerable prospecting for this ore. The principal work has been done near Brevard, Tran-

sylvania county; Canton, Haywood county; and near Goldsboro, Wayne county. While as yet no large deposit has been definitely located, these three are promising occurrences.

The deposit in Transylvania county is about 7 miles northeast of Brevard and $3\frac{1}{2}$ miles from Blantyre, a station on the Transylvania Railroad. The deposit has been developed by means of 7 shafts along the strike of the vein in a distance of 2,000 feet; and near one shaft the vein was exposed for 200 feet. The deposit has been estimated to be 18 feet wide, and is capped for a distance of 10 feet by limonite, which does not carry more than a trace of manganese oxide. Below this point the manganese oxides begin to come in, with the iron minerals predominating in the ratio of 5 to 1. These are so arranged, however, that the limonite is readily eliminated by hand-cobbing. The strike of the vein is in a general N. E.-S. W. direction, and it is dipping toward the east. Assays of this ore show it to vary from 22 to 57 per cent. of manganese, these representing two samples, one which was considered the poorest ore encountered and the other the best. An average sample of the ore, after cobbing to eliminate the yellow limonite, will contain from 45 to 50 per cent. of manganese.

Six samples representing various types of ore from this deposit gave the following results when analyzed:

ANALYSIS OF MANGANESE ORE FROM NEAR BREVARD.

	IRON (Fe).	PHOSPHORUS (P).	SILICON (Si).	MANGANESE (Mn).
1-----	16. 01	. 037	1. 56	43. 93
2-----	3. 26	. 071	. 39	57. 02
3-----	13. 44	. 109	. 93	45. 08
4-----	32. 37	. 207	3. 32	22. 54
5-----	5. 68	. 227	1. 34	48. 66
6-----	32. 02	. 505	1. 25	25. 34

Samples 1, 2, 3 and 5 all show a high per cent. of manganese, and with the exception of No. 5 are low in phosphorous and silicon. The portions of the ore deposit that are like Nos. 4 and 6 can be as a rule readily eliminated, so that the manganese contents of the commercial ore are kept high.

This is one of the more promising manganese properties in the State and has been developed by Mr. Robert Harris of Franklin, North Carolina.

The Haywood county deposit is located in Beaver Dam township, two miles southwest of Canton, on land of J. B. Rhodarmer and S. W. Smathers of Canton. Manganese ore has been found as float pieces over an area of about 300 feet wide and nearly a quarter of a mile in length, starting from a flat near the tobacco barn (west of the house) and extending in a northeast direction. The better samples of ore have been found nearer the southwest end. The only development work that has been done is a small cut in bank of road and parallel to it, about 40 feet long, which exposed a number of streaks of manganese ore, covering not over one-sixth of the exposed surface. At the west end of this cut a shallow pit 4 feet deep showed the streaks of ore to increase in width.

Only a very small percentage of the ore exposed is hard and compact and this was found mostly in the pit. Most of the ore is soft and friable and considerable of it is mixed with limonite. Near the northeast boundary of where float ore has been found, a streak of limonite mixed with manganese oxide was observed in the bed of a brook. This point is thirty or more feet higher than the cut and the manganese ore is overlaid by a blueish pipe clay.

Assays were made of this ore as follows: 1, of the hard compact ore from open cut; 2, soft friable ore from cut; 3, ore mixed with limonite; 4, ore from northeast boundary.

PER CENT. MANGANESE.

1-----	51.93
2-----	3.77
3-----	3.55
4-----	10.80

Near Goldsboro, Wayne county, a deposit of manganese is being investigated by Mr. S. G. Fry of Goldsboro. The ore on the surface has been assayed and gave the following results:

PER CENT. MANGANESE.

Compact black ore	13.4
Pink silicate	17.9

Many of the black masses of ore when broken open were found to contain this pink mineral, which fuses readily before the blow-pipe, to a black magnetic bead. A complete analysis was made of this mineral with the following results:

ANALYSIS OF SPESSARTITE FROM NEAR GOLDSBORO,
NORTH CAROLINA.

Specific gravity, 4,041.	PER CENT.
SiO ₂ -----	38.86
Al ₂ O ₃ -----	19.86
FeO -----	13.81
TiO ₂ -----	.52
P ₂ O ₅ -----	.39
MnO -----	20.16
CaO -----	4.27
MgO -----	2.24
H ₂ O -----	.36

This analysis shows the mineral to be spessartite, the manganese garnet.

It is not at all improbable but that as these properties are developed the manganese ore will be found to exist in quantity.

The value of a manganese ore varies with its percentage of this metal, and to be readily marketable it must contain at least 40 per cent., and be low in phosphorus. The price of these ores quoted at New York is \$ per ton for a 50 per cent. ore; for every unit (per cent.) less than this the value decreases; but for every unit above 50 per cent. there is a corresponding increase in the value of the ore.

PYRITE.

The mineral pyrite, a sulphide of iron (FeS₂) has been mined for the manufacture of sulphuric acid. The principal deposit is the Oliver mine, 4 miles from Crouse, Gaston county. This mine has recently been purchased by the Virginia-Carolina Chemical Company and it is very probable that the mine will not be operated for the present.

Near Toxaway, Transylvania county, a deposit of pyrite has been found by Dr. W. C. Fisher which gives indications of containing this mineral in quantity.

As a by-product in gold mining, the sulphuret concentrates, which are too low in gold to be treated either by the cyanide or chlorination process, offer a possibility of being profitably used for the manufacture of sulphuric acid. This is the intention of the Whitney Reduction Company of Gold Hill, who will have a large quantity of sulphurets which are too low in gold to be of value for the extraction of this metal.

The production of pyrite in 1901 was 4,000 tons valued at \$32,000, while in 1900 the production was 4,500 tons valued at \$14,625. This increase in the value of the ore was due to its higher percentage of sulphur.

CORUNDUM.

Corundum is a mineral that was formerly supposed to occur but sparingly in nature, but is now known to be quite wide in its occurrence. It has been found in North Carolina associated with peridotite, pyroxenite, amphibolite, anorthosite, serpentine, gneiss, mica-schist, quartz-schist, amphibole-schist and chlorite-schist. Of all these the most common occurrence is corundum in peridotite. During 1901 corundum deposits were mined which occurred in peridotite, quartz-schist and chlorite-schist. In recent years attempts have also been made to mine corundum in amphibolite, gneiss and amphibole-schist, but in every instance they could not be successfully operated either on account of the low percentage of corundum in the rock, or on account of the refractory nature of the rock, or the erratic occurrence of the corundum, which in a number of instances gave out entirely. In a few instances where the corundum occurred in the decomposed portion of the rock so that it could be separated by sluicing they were successfully worked, but as soon as the hard rock was encountered the mine had to shut down.

There are three names in constant use to designate the varieties of corundum: 1. Sapphire, which includes all of those corundums that are transparent to semi-transparent, of whatever color; 2. Corundum, including the translucent to opaque, of all colors; 3. Emery, which is a mechanical admixture of corundum and magnetite or hematite. The last two varieties are those used in the arts, for abrasive purposes; the emery being used in very much larger quantity than the corundum. It is of course the presence of corundum in the emery that gives it

its abrasive qualities and makes it of commercial value, and the abrasive efficiency of the emeries will vary according to their percentage of corundum.

Any corundum that is transparent is brought under the head of sapphire, although many of these have distinct names in the gem trade. These are taken up under the head of gems. The corundum gem or sapphire localities are usually distinct from those of corundum, although some very handsome gems have been found in some of the mines where corundum was mined for abrasive purposes, notably the Corundum Hill, at Cullasaja, Macon county.

OCCURRENCE.

Corundum, as it is mined for abrasive purposes, occurs as sand, crystal or gravel, and block corundum, sometimes all three types being found in the same deposit. The sand corundum consists of small grains, crystals or fragments of mineral scattered through the vein. The crystal corundum consists of crystals up to three inches in length. Often these crystals have parting planes so thoroughly developed that they often cause the corundum in crushing to break up into regular rhombohedrons, this continuing even to the finer sizes, which causes the grains to break down when in use. This continued regular breaking destroys the cutting efficiency, which is dependent on its irregular fracture, which produces the best cutting edge. The block corundum often occurs in masses from ten to a thousand pounds in weight of almost pure corundum. Then again, it occurs in large masses intimately associated with hornblende, feldspar, etc., making a very tough and difficult rock to work. Often the only way to break these masses is to build fires over them and then to suddenly cool them by pouring water upon them. The parting planes are at times very noticeable in the block corundum and are detrimental to the commercial product in the same way as to the crystal corundum.

There is a constant demand for corundum, more at the present time than is being supplied, and this has caused more thorough prospecting to be undertaken for this mineral. Although there are over 60 localities known in North Carolina where corundum occurs, which extend over a considerable portion of the western part of

the State, it is at present only known to occur in commercial quantity in the four counties, Clay, Macon, Jackson and Transylvania. These corundum deposits are unquestionably of great economic importance to the State, and considering the energy with which the industry is now being pushed, it will be but a short time when the corundum will be bringing a considerable income into the State. The principal mines are the Corundum Hill at Cullasaja and the Mincey at Ellijay, Macon county, the Buck Creek or Cullakeenec, Clay county; the Socrates, Bad Creek, and White Water near Sapphire, Jackson county; and the Burnt Rock and Brockton in Transylvania county, the corundum at all these being associated with peridotites; the Sealy mountain in Clay county, where the corundum is associated with quartz schist; and the Caney Creek mine in Jackson county, where the corundum occurs in a chlorite schist. Besides these, there are a number of other deposits that are being developed and others that are promising prospects, as the property of the North Carolina Corundum Company on Little Buck creek, Clay county; the Gray and Robinson properties on Ellijay creek, Macon county; a deposit in Woodfin Cove, Balsam Mountain, near Hall, Jackson county; the Corbin and Grimshawe properties near Montvale, Transylvania county; and the Carter mine, Madison county, near Democrat, Buncombe county.

The only mines that have produced any quantity of corundum during the past year are: The Corundum Hill mine at Cullasaja, Macon county, whose production has been smaller than usual, and which after being cleaned was shipped to Chester, Massachusetts, where it was sized and prepared for market; the Sealy mountain mine in Clay county, which has for the first time produced corundum for the market, it being cleaned and sized at the mine; and the Caney Creek mine, Jackson county.

The North Carolina Corundum Company have done considerable development work on their property at Little Buck creek, Clay county, and they report very encouraging results regarding the amount of corundum exposed. The Toxaway Company, who own most of the mines in the vicinity of Sapphire, Jackson county, have done a little work on their corundum deposits, sufficient, however, to expose the corundum at the Brockton mine and on the Corbin

property. The National Abrasive Manufacturing Company own the corundum deposit on Cancy creek, Jackson county, where the corundum occurs in a mica and chlorite-schist, and the work that they have done here, while not actually demonstrating the quantity of corundum, does show that it is of good quality, and that it will make a good wheel.

USES.

The uses of corundum are very limited and can be divided into two general heads—gems and abrasives.

Both corundum and emery are used in the manufacture of abrasive materials, and these are on the market in three forms—as wheels and blocks of various shapes and sizes; as emery paper; and as the grains or powder. The last two need no further explanation.

The shapes of the corundum and emery wheels and bricks, or stones, are very varied, being adapted to all kinds of grinding. The principle of these wheels is the same as that of the rotary file, and as the points of a file become dull from using, so also do the grains or points of the emery and corundum in the wheel. It is necessary, therefore, in making a wheel that it be made of such a temper or grade that when these grains become dull or rounded they will fall away or will be readily removed by a truing tool, leaving fresh sharp ones exposed. The grade of a wheel depends upon the character of the work for which it is to be used, and the bond should be such that it will wear away a little faster than the emery or corundum, and thereby always leave the sharp edges ready for cutting. The greatest economy results when the bond does not wear away until the grains of emery or corundum have become rounded and dulled.

There are three types of wheels known to the trade—the vitrified, chemical, and cement—the names being derived from the processes by which they are manufactured. In the manufacture of all of them the corundum or emery used is in grains of uniform size, but these vary with the grade of wheel to be made. The vitrified wheel is the most important and the one more generally used, although for some work one of the others is often preferable, and for the manufacture of very large ones the commercial wheel is especially adapted.

Where formerly North Carolina and Georgia were the only States that were producing corundum, and all the deposits were occurring in peridotite, this mineral is now being mined in Ontario, Canada, and in Montana, where the mineral occurs in syenite, and the former mine is shipping considerable quantities of this mineral into the United States. The Montana mines expect to put corundum on the market during 1902. These two deposits will be strong competitors of North Carolina corundum, but there should be no difficulty for the North Carolina deposits to compete with them, for the corundum is as good quality. While the market for corundum is a limited one, and there could be easily an oversupply, yet with a reduction in price for this mineral, there would be a correspondingly increase in the demand, which would be at the expense of emery. The artificial abrasives, carborundum and artificial corundum, are competitors of corundum and this is especially true with corundum at its present price. There has been a constantly increasing demand for abrasives and there will continue to be an increase just so long as our manufacturing industries continue to grow. There will be changes in the abrasive industry, but it will not be in a reduction of the production of abrasives, but in the kind of abrasives that will be used. As corundum has the highest abrasive efficiency of all the natural abrasives, it will be more in demand, if the price can be kept sufficiently low.

In 1901 the production of corundum was 325 tons valued at \$48,840, which is an increase of 120 tons and of \$12,000 in value over that of 1900, the production of which was 205 tons valued at \$36,840. This increase is due principally to the production of the Sealy Mountain mine. With, however, the amount of this mineral that is known to exist in the State and the demand that there is for it, there should be five times this amount produced.

GARNET.

The name garnet is used to designate a group of minerals which have many identical and similar physical properties and similar chemical properties. They all crystallize in the isometric system, with the dodecahedron and trapezohedron as the common forms.

They vary in specific gravity and color according to their chemical composition. The different minerals that have been identified as belonging to the garnet group are given in the following table, together with their chemical composition, specific gravity and hardness:

LIST OF GARNETS.

GARNET.	Chemical Composition.	Specific Gravity.	Hardness.
Grossularite (Calcium—aluminum garnet)---	$\text{Ca}_3\text{Al}_2\text{Si}_3\text{O}_{12}$	3.55—3.66	6.5—7.5
Pyrope (Magnesium—aluminum garnet) ---	$\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$	3.6 —3.7	6.5—7.5
Almandite (Iron—aluminum garnet)-----	$\text{Fe}_3\text{Al}_2\text{Si}_3\text{O}_{12}$	4. —4.15	7. —7.5
Rhodolite (Magnesium—iron— aluminum garnet)-----	$\left. \begin{array}{l} 2\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12} \\ \text{Fe}_3\text{Al}_2\text{Si}_3\text{O}_{12} \end{array} \right\}$	3.83	7.5
Spessartite (Manganese—aluminum garnet).	$\text{Mn}_3\text{Al}_2\text{Si}_3\text{O}_{12}$	4 2	7. —7.5
Andradite (Calcium—iron garnet) -----	$\text{Ca}_3\text{Fe}_2\text{Si}_3\text{O}_{12}$	3.8 —3 9	7.
Uvarovite (Calcium—chromium garnet)----	$\text{Ca}_3\text{Cr}_2\text{Si}_3\text{O}_{12}$	3.41—3 52	7.5

Of the above garnets, those that are used as abrasives are pyrope, almandite and andradite. In the above table the theoretical composition is given for the different varieties, but they will be found to vary, as ferrous iron, calcium, magnesium and manganese are isomorphous with each other and are capable of replacing each other, which is also the case with ferric iron and aluminum. As is seen, the hardness of the different garnets varies from 6.5 to 7.5. The uses of garnet are in the manufacture of sand-paper or "garnet paper" which is used extensively by boot and shoe manufacturers; and in the manufacture of abrasive wheels which are sold as emery or corundum wheels. Practically all the garnet mined in North Carolina is used for this latter purpose, and is the almandite variety. Its abrasive efficiency is good, and for some kinds of grinding it is especially adapted, but on account of its low fusibility, it cannot be used in the manufacture of the vitrified wheel. Garnets are also used as gems, and these are described beyond.

Garnet is one of the most widely distributed minerals and is found in many of the crystalline rocks. It is commonly associated with mica (muscovite) in pegmatitic dikes, although sometimes but sparingly; and often occurs abundantly in gneisses and schists. Bands

of these rocks often contain a large percentage of garnet while the enclosing rock contains practically none; and it is the occurrences in these bands that constitute for the most part the commercial sources of this mineral.

There are a number of localities in North Carolina that have been worked for garnet with considerable success. For the most part the occurrences are similar, being bands of garnetiferous-gneiss in ordinary gneiss, which are up to 50 or more feet in width and some of which average 30 per cent. of garnet.

The principal deposits are in Jackson county, one, the Sugar Loaf mine, being near the summit of Sugar Loaf Mountain, $1\frac{1}{2}$ miles from Hall, a station on the Murphy branch of the Southern Railroad. Another, the Savannah mine, is on the head-waters of Betty creek on the east slopes of the Cowee mountains. The third is the Presley near Speedwell in the upper Tuckaseegee valley, about 12 miles from Sylva on the Southern Railroad. The garnet at all three of these localities is the almandite variety and some of it has been sold under the name of ruby corundum. On the slopes of Scaly Mountain in Clay county, there are bands of quartz-schist that are corundum and garnet-bearing, which are being mined for corundum and the garnet is saved as a by-product. About 5 miles west of Spruce Pine, Mitchell county, near the Burnsville road, there is a large deposit of massive garnet that occurs in pockets in a gneissic rock. Associated with this garnet there is considerable epidote. At the present time its distance, 25 miles from the railroad, prevents its being an available source of garnet. With, however, the completion of the railroad that is now being built through Yancey and Mitchell counties, these deposits may prove to be of some considerable commercial value.

The principal production of garnet for abrasive purposes during the past two years has been confined to Jackson county and the two mines that have been worked exclusively for this mineral are the Sugar Loaf and the Presley. A small amount of garnet has been produced in 1901 as a by-product from the corundum mine on Scaly mountain, Clay county. The total production of garnet in 1901 was 775 tons valued at \$43,000 as compared with 300 tons valued at \$18,000 in 1900.

The plant at the Sugar Loaf mine is being increased and the production of garnet in 1902 will very probably be much larger than in 1901.

MICA.

OCCURRENCE.

It is the varieties of mica known as muscovite and phlogopite to which all the commercial mica belongs, and in North Carolina it is the muscovite mica that is commonly found. It is very widely distributed, being a component of many of the crystalline and sedimentary rocks. When, however, it occurs in blocks or masses which can be split into sheets an inch or more in diameter, it has a commercial value which increases with the size of the cut sheets and these vary from 1x1 to 8x10 inches. These deposits of commercial mica occur for the most part in pegmatitic dikes or veins which are found in granite and in hornblende and mica gneisses and schists. These dikes or veins, which vary in thickness from a few inches to several hundred feet, are often very irregular and have arms or "veinlets" branching off from them in many directions. At times they are parallel to the bedding or schistosity of the gneiss or schist and again they break across this at varying angles; both of these phenomenon often being observed in the same dike.

In character these pegmatitic dikes are very similar to a granite and sometimes they are called "coarse granite"; and if we could conceive of the constituents of the granite being magnified a hundred times or more, we would have an appearance that would be very similar to a pegmatitic dike. These dikes consist of quartz, feldspar and muscovite-mica in varying proportions. In some portions of the dike or vein the quartz and feldspar are nearly equally distributed, while in others sometimes one and again the other will predominate. Feldspar has been observed that has crystallized out in masses of more than a ton in weight, and well developed crystals of this mineral have been observed that were 3x11½ feet. Sometimes the feldspar, quartz and mica have separated out in rather small masses while at others they are separated out on a much larger scale. As far as I have observed the occurrence of mica, the veins that yield the best com-

mercial mica are those in which the three minerals have crystallized out in the larger masses. Where the feldspar and quartz are rather small, the mica is apt to be small and often is of poor quality. All the mica veins do not carry commercial mica, and usually the dikes two feet and less in width are barren of mica that would have a commercial value. Still, on the other hand, all the wide veins do not carry a mica that would make profitable mining, for in some, the mica is in such small crystals and blocks, that sheets cannot be cut over an inch or two in diameter.

Regarding the mica itself as it occurs in the vein, it is usually in rough crystals called blocks or books, distributed sometimes nearly evenly in the vein and at others nearer the contact of the vein with the country rock. These blocks of mica are sometimes nearly perfect in their crystalline form which is monoclinic, but rhombic or hexagonal in outline. While these blocks usually vary in thickness from 3 to 15 inches in diameter and 1 to 18 inches in thickness, they have been found as much as four feet in diameter. These blocks have at times been converted into what is called ruled mica, the mica being cut into narrow strips whose edges are parallel to the intersection of the prism and base edges of the crystal, or "A" mica, where the sheets are striated on two adjacent edges. The percentage of mica in these pegmatitic dikes will seldom, if ever, average over 10 per cent. of the contents of the dike and it will sometimes not be over 1 per cent. Often the dike will have the appearance of containing a very much larger percentage, on account of a number of blocks of mica being clustered together in bunches and almost touching one another; while in other portions of this same dike, there may be an absence of mica for a distance of from 5 to 20 feet and thus the general average of mica in the dike will correspond to 1 to 10 per cent.

The principal deposits of mica in North Carolina are in Mitchell, Yancey, Jackson, Haywood and Macon counties, the two former having the larger proportion. In Mitchell county there are 66 and in Yancey 45 mines. These mines have been worked for the most part by crude methods, but even under these conditions, the Clarissa, Sink-hole, Hawk, Double Head, Spread Eagle, Deake and Cloudland mines in Mitchell county; the Ray mine in Yancey county; the Big

Ridge and Shiny mines in Haywood county; and the Iola, Burningtown, and Raby mines in Macon county have produced collectively considerably more than a million dollars worth of mica, and it is not unreasonable to suppose that under more favorable conditions the supply will be greater than what it has been in the past. Many of these old mines are now being reopened and worked with considerable success. North Carolina mica is still, as it always has been, superior to any other in the world.

ASSOCIATED MINERALS.

There are a number of minerals that occur associated with the mica in these pegmatitic dikes, some of which have a commercial value, principally as gems, and these are taken up on page 50. Below is given a list of the minerals that have been found in these pegmatitic dikes and those marked with an asterisk have been obtained in sufficient quantity to be of value commercially.

LIST OF MINERALS FOUND IN THE PEGMATITIC DIKES OF NORTH CAROLINA.

Quartz* (massive, crystallized, and smoky).		Magnetite.
Albite.*		Gahnite.
Oligoclase.	} Feldspars.	Hematite.
Orthoclase.*		Menaccanite.
Microcline.*		Limonite.
Kaolin.*		Rutile.
Muscovite.*	} Micas.	Opal (var. hyalite).
Bootite.		Pyrite.
Beryl* (emerald, yellow and aquamarine).		Molybdenite.
Almandite.	} Garnets.	Pyrrhotite.
Andradite.		Uraninite.*
Tourmaline.		Gummite.*
Zoisite (var. thulite).		Autunite.
Epidote.		Uranotil.
Enstatite.		Phosphuranylite.
Actinolite.		Columbite.
Cyanite.		Samarskite.*
Pyrophyllite.		Rogersite.
Allanite.		Hatchettolite.
Chabazite.		Fergusonite.
Zircon.*		Monazite.
		Apatite.
		Graphite.

The majority of these minerals are found in the mica mines or pegmatitic dikes of Mitchell, Yancey and Madison counties. In the other mica-producing counties the associated minerals are less in number and rarer.

A number of these by-product minerals are gems; but there are two, feldspar and quartz, that may become of some considerable value, especially the former. This is used in pottery manufacture and by utilizing the available water-powers for grinding it, it should be able to be placed on the market at a fair profit. There are a number of the mines in Yancey county and also Mitchell county that could furnish it in quantity. In the more southern counties the feldspar has usually suffered too much kaolinization to be of value for this purpose.

USES.

Besides the use of mica for cutting into sheets of varying sizes, which are used for stoves, chimneys for the incandescent lights, etc., there is a large quantity of the smaller pieces of mica that are cut by machines into small circular disks (one inch in diameter), and rectangular pieces $\frac{3}{4} \times 2$ inches which are used for insulation purposes in electrical apparatus. While the use for stoves has decreased very rapidly during the past ten years, there has been a corresponding increase in its use for electrical apparatus. Of all the mica that is mined, there is probably not over 10 to 15 per cent. that can be cut into sheet mica, the rest being waste or scrap mica. In some of the mines in the western part of the United States there is hardly a 3 per cent. yield of cut mica. In the North Carolina mines, the mica obtained will average the highest percentage of cut mica. Selected masses or blocks of mica will often average from 30 to 40 per cent. and occasionally as high as 75 per cent. There are a number of reasons for this large percentage of waste mica: The irregularity of the blocks of mica, and of the individual sheets; the "ruled" and "A" mica reduce the size of sheets that can be cut; or prevent entirely any sheets being cut from the block; specked and stained mica; and the destruction of sheet mica by having garnet, tourmaline or quartz crystallized out between the folia. Some of the small perfect pieces

of mica from the cutting of the large sheets are re-arranged and cemented together into larger sheets, which are cut into various shapes and are known as micanite. For some purposes the large sheets of micanite answer as well as the perfect sheets and are of course much cheaper. The waste or scrap mica, which is not suitable for any of the above purposes, has a value when ground to a flour as in the manufacture of wall papers, lubricants, etc. Another use for scrap mica that has been devised during the past few years is in the manufacture of a covering for boiler-tubes and steam pipes in general. The scraps of mica are not ground but are broken to approximately the same general dimension—about one-half by a quarter of an inch. These are arranged with their longer direction and face parallel to the length of the coil, which consists of a wire net, pressed into the shape of the pipe or tube and against which is the layer of scrap mica kept tightly in place by means of heavy canvas. This kind of boiler-tube covering can be cheaply made and as mica is a non-conductor of heat, it should give good satisfaction, if not equal to or better than the asbestos coverings. North Carolina offers a very favorable location for a plant to manufacture these as it can produce a large supply of scrap mica and has also an abundant supply of available water-power. It is the commercial value of this scrap mica, which is from \$8 to \$10 per ton delivered at the railroad, that has made it possible to work some of the mines that would otherwise have been unprofitable; for it must be remembered that this waste mica represents 75 to 95 per cent. of the mica mined.

The value of the plate mica per pound varies with the size of the sheet, which is from 15 cents for the smaller sizes to \$3 and more for the larger.

LOCALITIES.

During the past year, many of the mica mines throughout the State have been worked quite vigorously, and the result is a larger production of sheet mica than for many years past. The production, however, of scrap mica was less, this being due to the fact that for a number of years the old dumps at the mica mines have been a fruitful source of scrap mica; but as these have been more or less thoroughly culled over, the production is now largely the waste from

present mining. There have been a large number of small producers (from \$50 to \$500) in the different counties that have worked their mines a few days at a time. There are but few that have been worked continuously throughout the year. A number of new properties, and also old mines, have begun to be worked during the past year, as the mines of the Carolina Mining Company on Beaver creek, near Jefferson, Ashe county; the Mattocks mine near Canton, Haywood county, which is being operated by Mr. J. E. Mattocks; and the Reeves mine near Montvale, Transylvania county. The mica that is being produced in the State does not begin to represent what it should be. By the consolidation of many of the mica mines they could be put on a paying basis and would be profitable to the investor, while by the present method of mining many of them do not more than pay expenses. There are many good deposits of mica in the State that can be worked to advantage and as these are taken up and mining operations for mica are carried on to the same extent as in other kinds of mining, they will be found to be as profitable.

There is no method by which it can be accurately determined from the appearance of a pegmatitic dike at the surface, whether or not at greater depths it will contain large blocks of mica and make profitable mining; but if there is a considerable exposure of the surface dike, and if in this distance there are indications of large blocks of mica, or of mica in paying quantity, it can usually be considered that this represents what will be found deeper. There are a few facts, however, regarding mining and prospecting for mica that can be used to advantage which have been enumerated by Prof. J. A. Holmes as follows:

“Deposits of commercial mica are most likely to be found:

“(1). In regions where the country rock is either mica schist, hornblende schist, or a somewhat schistose gneiss.

“(2). In such of these regions as where the crystalline schists and gneisses contain numerous fairly large and coarsely crystalline pegmatite dikes.

“(3). In a region where these pegmatite dikes have not been greatly crushed or sheared in connection with great earth movements, such as accompany the result in the formation of mountains, it

will probably be found that these movements have destroyed in large measure the value of the mica.

“(4). Where on some portion of the exposed surface of these dikes occasional blocks of good mica may be observed several inches in diameter, the outlook may be regarded as favorable to development. Of course the size of the blocks exposed on the surface of one of these dikes cannot be taken as a positive indication as to what the size of the blocks will be at any considerable depth below the surface; but as a rule it has been fairly assumed that when along the surface of one of these pegmatite dikes which is exposed for a considerable distance no large blocks of mica are to be observed, none are likely to be found at greater depths.

“(5). When after a limited excavation it is found that practically all or a large proportion of the mica discovered at that point is extensively ruled or generally specked with iron, the probabilities are that these defects will continue in depth, and this will of course greatly diminish the value of the product and consequently the chances of successful mining.”

PRODUCTION.

In 1901 the production of mica was \$79,849 of plate mica, and 1,775 tons of scrap mica valued at \$14,200. Compared with the production for 1900, which was \$65,200 of plate mica and 5,945 tons of scrap mica, valued at \$36,262, there is an increase of \$14,649 in value of plate mica and a decrease of \$22,062 in scrap mica. The approximate value of the production of sheet or plate mica by counties is given in the following table, together with that for 1900:

VALUE OF PRODUCTION OF SHEET MICA IN 1900 AND 1901 BY COUNTIES.

COUNTY.	1900. Value of Plate Mica.	1901. Value of Plate Mica.
Haywood -----	\$ 11, 000	\$ 11, 500
Jackson -----	7, 000	8, 740
McDowell -----	1, 000	500
Macon -----	5, 200	
Mitchell -----	26, 722	33, 506
Stokes -----	1, 000	
Transylvania -----	500	600
Yancey -----	12, 788	25, 003
Total value -----	\$ 65, 200	\$ 79, 849

Although so many of the mica mines throughout North Carolina have been closed, it has not been for want of good mica; for many of them were shut down with a quantity of good mica in sight. The reasons for this are that the owners had no capital with which to equip their mines so as to be able to contend with water or to carry on deep mining; nor in many cases were they able to bear the expense of blasting when the harder rock was encountered in depth. Then again, as their mine became a little difficult to work, they would abandon it, and take up another prospect where the mining was easier, and keep on in this way. There are hundreds of small openings that have been made for mica throughout the State and it was this method that led to the term of "ground-hoging" for mica which is often applied to mica mining. There is mica of the best quality and in quantity in North Carolina that will make profitable mining propositions.

QUARTZ.

Quartz, an oxide of silicon, or as it is sometimes commercially called, silica or silex, is one of the commonest minerals and is very widely distributed in nature, being a constituent of many of the crystalline rocks, and the main constituent of all sandstones. It is also found in quantity at widely varying localities, notably as a constituent of pegmatitic dikes. The uses of this mineral are quite varied, it be-

ing used in the manufacture of a paste that is used for wood finishing; in the manufacture of pottery and tile; of sand-paper; in certain scouring soaps and powders; in the manufacture of a wood filler, and in glass; and in certain instances it is mined for a flux in copper smelting. Where it is colorless and perfectly transparent it is of considerable value for cutting into spheres, cubes and other forms for ornamental purposes. There are also many varieties of quartz that are of value as gems, see page 51.

There are large deposits of quartz in the mountain counties of North Carolina, some of which should be available for some of the first purposes enumerated above. It would not pay to ship the rough quartz, but by utilizing the available water-power, it does seem as though the ground product could be marketed at a profit. As a by-product in mica mining, its cost of production would simply be in the grinding, and with favorable transportation rates, it should be able to compete with quartz produced in other localities. The completion of the railroad in Yancey and Mitchell counties will make this a more feasible proposition for the quartz deposits of those counties.

The only quartz that has been mined in North Carolina during 1901 was in Cherokee county and was used for flux in the copper smelter at Ducktown, Tenn. This amounted to 3,000 tons valued at \$7,500. During 1902 this production will undoubtedly be very materially increased.

FELDSPAR.

Inquiries have been received regarding the occurrence of feldspar in North Carolina, that would be suitable to grind and use in the manufacture of pottery. There are two classes of feldspar that can be used for this purpose, the potash and soda feldspars. Of these the potash is the more valuable and more in demand. Orthoclase and microcline, the two potash feldspars, have the following theoretical composition:

	PER CENT.
Silica, SiO_2	64.7
Alumina, Al_2O_3	18.4
Potash, K_2O	16.9

There is nearly always a little soda (Na_2O) that replaces a portion of the potash.

The common soda feldspar is albite, which has the following theoretical composition:

	PER CENT.
Silica, SiO_2 -----	68. 7
Alumina, Al_2O_3 -----	19. 5
Soda, Na_2O -----	11. 8

In this case there is more or less of the soda replaced by potash. Lime, CaO , is often found in small quantity in the soda feldspars and as this begins to predominate there is a transition to the pure lime feldspar, anorthite.

Feldspar is a common mineral in North Carolina as a constituent of all granites and gneisses and of pegmatitic dikes. A great deal of it, however, found near the surface especially in the southern counties has been either partially or wholly kaolinized, so that it is not of value as a feldspar for pottery manufacture; but in many cases has formed extensive beds of kaolin. In the northern counties, however, fresh unaltered feldspar occurs in quantity. These are found for the most part as constituents of pegmatitic dikes that are being worked for mica, and its production would be in many cases a by-product of mica mining. In the table below are given the localities and percentages of potash, soda and lime of a number of feldspars.

NORTH CAROLINA FELDSPARS.

	PER CENT.				
	POTASH. (K_2O)	SODA. (Na_2O)	ALUMINA. (Al_2O_3)	LIME. (CaO)	SILICA. (SiO_2)
1-----	11. 66	5. 95	18. 34	. 08	64. 25
2-----	9. 50	3. 62	21. 20	Trace.	63. 52
3-----	8. 73	6. 65	20. 20	Trace.	63. 55
4-----	8. 39	7. 64	19. 66	Trace.	62. 95
5-----	7. 55	7. 85	19. 24	Trace.	64. 75
6-----	7. 28	7. 00	19. 04	. 12	65. 15
7-----	3. 94	7. 91	22. 26	1. 41	64. 55
8-----	2. 91	10. 04	19. 90	None.	64. 85
9-----	. 04	8. 35	21. 60	. 64	65. 18

1. Young mine, Dobag, Yancey county.
2. Irby mine, near Spruce Pine, Mitchell county.
3. Ray mine, near Burnsville, Yancey county.
4. Averys Meadow mine, Plumptree, Mitchell county.
5. Tolly Bend mine, near Micaville, Yancey county.
6. Flat Rock mine, Flat Rock, Mitchell county.
7. Charlie Robertson mine, near Micaville, Yancey county.
8. Wiseman mine, near Spruce Pine, Mitchell county.
9. Cloudland mine, near Bakersville, Mitchell county.

With the water-powers that are available in the vicinity of where these feldspar deposits occur, which could be utilized for grinding them, and with the construction of the railroad across these counties, connecting with the Ohio River railroads, the ground feldspar should be able to be landed at the potteries in competition with that from other localities.

When it is considered that there are to be found in North Carolina as fine beds of clays as can be obtained; that the other constituents necessary for pottery manufacture are also at hand; and that manufacturing can be carried on as cheaply if not more so than in the Northern States, the question arises why should not pottery industries themselves be established in North Carolina, instead of shipping out the raw materials necessary to maintain these elsewhere.

GEM MINERALS.

There are many of the gem minerals found in North Carolina, and deposits of some have been found in sufficient quantity to become regular producers. There has been but little systematic search for these minerals, but accidental discoveries have been made in various places that have in some cases led to the opening of good deposits of gem material, and there are now a number of companies who are mining in the State exclusively for gems. The principal gem localities are in Macon, Yancey, Mitchell, McDowell, Burke, Alexander and Iredell counties.

The minerals that are classified as gem minerals can be brought under three groups; one consisting of those that are capable of being cut into gems for jewelry, as diamond, ruby, etc.; another consisting

of those that are cut into spheres, cubes and other forms, or are carved, and which are used for ornamental purposes, as quartz, serpentine and jade; and third, those that make handsome mineral specimens, as rhodochrosite, pyrite, etc. In the following list are given the minerals that come under some one of the above groups that are known to occur in the United States, and those that have already been found in North Carolina are marked with an asterisk.

LIST OF GEMS AND GEM MINERALS OCCURRING IN THE UNITED STATES.*

Diamond.*	rose quartz.*
Corundum, oriental ruby.*	asteriated quartz, "star quartz."
oriental sapphire.*	aventurine.*
oriental emerald.*	quartz, cat's eye.
asteriated sapphire.*	gold-quartz.*
oriental amethyst.*	tourmalinated quartz.*
oriental topaz.*	hornblende in quartz.*
Topaz.	gothite in quartz, onegite.
Beryl, aquamarine.*	rutilated quartz, sagenite.*
emerald.*	fleeches d'amour.
golden.*	Thetis hairstone.*
blue.*	agate.*
emerald matrix.*	carnelian.*
Garnet, almandine (precious).*	chalcedony.*
essonite (cinnamon).*	chrysoprase.*
pyrope (Bohemian).*	hydrolite.
rhodolite.*	moss-agate, mocha stone.*
spessartite.*	onyx.
schorlomite (titaniferous).	rainbow agate.
topazolite.	royal agate.
uvarovite.	sard.
Tourmaline, achroite.	jasper.*
Brazilian emerald.	bloodstone (heliotrope).
indicolite.	jasper, agate.*
rubellite.	Lydian stone (basante,
Quartz, rock crystal, "pebble."*	touchstone).
amethyst.*	novaculite.*
citrine.*	silicified wood.
smoky quartz.*	agatized wood.
cainrorm stone (Scotch topaz).*	jasperized wood.
Spanish topas.*	Opal, opal agate.
morion.*	fire opal.
plasma, prase.*	lechosos (milky opal).

* This list has been made up from one used by Mr. George F. Kunz, of the U. S. Geological Survey.

moss opal.	Cyanite (blue and green).*
noble (precious).	Andalusite (maele, chiastolite).
sun opal.	Zoisite (thulite).*
opaline, opal matrix:	Epidote.*
hyalite.*	Chlorastrolite.
hydrophane.	Prehnite (zonochlorite).
wood opal.	Thomsonite (mesolite).
opalized wood.	Chondrodite.
Feldspar, labradorite.*	Dumortierite in quartz.
microcline (amazon-stone).*	Serpentine.*
oligoclase (sunstone).*	Agalmatolite (figure stone).
orthoclase (moonstone).*	Catlinite (pipestone).
obsidian (volcanic glass).	Chrysocolla.
marekanite (mountain mahogany).	Titanite (sphene).*
moldavite.	Pyrite.*
Bronzite.*	Hematite.*
Pyroxene (diopside).*	Rutile.*
Hypersthene.*	nigrine.
Spodumene, hiddenite.*	Diaspore.
Nephrite.	Prosonite.
Pectolite.	Malachite.
Rhodinite.	Azurite.
Crocidolite.	Rhodocrosite.
Iolite (cordierite).*	Turquoise.
Sodalite.	turquoise matrix,
Lazurite (lapis lazuli).	odontolite (bone turquoise).
Olivine (chrysolite, peridot).*	Variscite.
Phenacite.	utahlite.
Scapolite (wilsonite).	Amber.
Willemite (troostite).	Fire marble (lumachelle).
Zircon.*	Fossil coral.

With more systematic search for these minerals, others will be found in North Carolina and some of those already known will be found in greater abundance.

DIAMOND.

In North Carolina diamonds have been repeatedly found; and there are now ten authentic ones whose occurrences are fully established. Besides these, three others have been reported. They have been distributed over a wide area in the counties of McDowell, Burke, Rutherford, Lincoln, Mecklenburg and Franklin. With the exception

of Franklin, all of these counties are in the eastern drainage basin of the Blue Ridge. Two have been found on Brindletown creek, Burke county; one at the Twitty mine in Rutherford county; one near Cottage Home, Lincoln county; two on Todd Branch, Mecklenburg county; three from Muddy creek, McDowell county; and one from the Portis mine, Franklin county. Besides these, one is reported from Richmond county, and another from Rutherford county. The largest diamond, weighing 4 1-3 carats, was found in 1886 on the farm of Albert Bright in Dysartville.

CORUNDUM GEMS, RUBY AND SAPPHIRE.

There is no State or country that excels North Carolina in its variety of corundum gems. They are found red, ruby-red, sapphire-blue, dark blue, various shades of green, violet and purplish, rose, pink, brown, yellow, gray and colorless. The corundum gems are determined by the color and there are, at the present time, nine varieties that are commonly recognized by the lapidaries. In the arts these are usually prefixed by the word "oriental" to distinguish them from other gems of the same name, but whose mineral composition and character are entirely different. These varieties are as follows:

LIST OF CORUNDUM GEMS.

Oriental or true ruby....	Red of various shades.
Oriental Sapphire.....	Blue of various shades.
Pink Sapphire	Rosé or Pink.
White Sapphire. }	Colorless.
Diamond spar. }	
Opaline. }	Pale blue or bluish white.
Girasol. }	
Hyaline. }	
Oriental Amethyst.....	Purple.
Oriental Emerald.....	Green.
Oriental Topaz.....	Yellow.
Star Sapphire. }	Opalescent.
Chattayant. }	
Asteria. }	

The locality that has furnished the greatest variety of these gems is the Corundum Hill mine, at Cullasaja, Macon county. Sapphires

have also been found at the Grimshawe mine, Montvale, Transylvania county, and at Sapphire, Jackson county.

The North Carolina locality which has attracted considerable attention for the occurrence of corundum gems is a tract of land in Macon county, between the Caler fork of the Cowee creek and Mason Branch, two tributaries of the Little Tennessee river. Ruby corundum of exquisite color and transparency has been found in the gravel deposits of the Caler fork of Cowee creek. Although but a very small percentage of the corundum found in the gravel was transparent, nearly all was of the ruby color. Beautiful rubies of a rich pigeon blood red color have been found here, that could not be told from the Burmah stones. The best stone that has thus far been found is valued at \$1,500. Many smaller gems have been obtained that were perfectly transparent and of good color. Sapphires to the value of about \$45 were obtained in 1901.

RHODOLITE.

Associated with these rubies is the gem rhodolite, one of the garnet group. It has a variety of shades of color, which for the most part are similar to the delicate rose-like tint of the rhododendron. Then again, its remarkable brilliancy vies with that of the diamond. Most of the varieties of garnet are only beautiful by transmitted light and otherwise exhibit dark shades of color, but rhodolite gives most striking effects of beautiful and varied coloring by reflected light. When first discovered the rhodolite was mistaken by many jewelers for a variety of ruby, and not until they had tested it would they believe otherwise. The rhodolite has only been found in North Carolina, and in a very limited area, which includes the gravels of the streams that rise on Mason mountain, Macon county. The largest rhodolite found in 1901 weighed $43\frac{1}{2}$ carats. The value of these gems found in 1901 was \$20,350.

GARNET GEMS.

Beside the rhodolite referred to above, the almandite and pyrope varieties of garnet have been found extensively in many sections of the State. Good gems of these varieties have been found in Macon, Alexander, Yancey, Mitchell, McDowell, Burke, Caldwell, Ca-

tawba and Lincoln counties, but the best colored and most transparent ones have been obtained from the first two counties. At many of the mica mines, transparent garnet crystals are found, flattened out between the foliæ of the mica. Otherwise than as gem minerals garnet is widely distributed in the State, and is a constant constituent of many of the micaceous and other igneous rocks, and as stated on page 36, occurs at times in sufficient quantity to be of value for abrasive purposes. The value of these garnets obtained in 1901 was \$625.

BERYL.

This is a mineral that varies in color from emerald green, pale green and sea green to yellow, light blue, and white. The emerald green color is due to the presence of a little chromium and that variety is highly prized as a gem when clear and free from flaws. The beryl emerald is the one that is commonly sold at the present time, the oriental or true emerald (the green variety of sapphire) being one of the rarest of the gem stones. North Carolina has furnished some very handsome beryls of emerald green color, some of which have been cut into fine stones. The most noted locality is near Hiddenite, Alexander county, North Carolina. The first emeralds that were obtained in this locality were found in the soil and it was not until 1881 when the Emerald and Hiddenite Mining Company was organized that any direct mining was undertaken. As the deposits were followed downward through the soil, the unaltered rock was encountered and, as the work was extended into this, their exact occurrence was seen. They occur in pockets of quartz associated with rutile, hiddenite, quartz, muscovite, dolomite, pyrite, garnets, etc., all of which are well crystallized. The rutile found here is the finest that has been observed in any locality in the world. It is a mineral of a nearly black color by reflected light, but a deep red in thin splinters by transmitted light and is often used for cutting into stones for seal rings as a substitute for the black diamond which it somewhat resembles when cut. The quartz associated with the emeralds is exceptionally well crystallized and has furnished some of the most modified crystals ever found.

The largest emerald crystal found here was a very perfect specimen

of a fine but somewhat light green color, which was doubly terminated and weighed $8\frac{3}{4}$ ounces. One of the largest stones cut weighed $42\frac{3}{8}$ carats and was of a somewhat light green color.

On Crabtree mountain, between Brush and Crabtree creeks, Mitchell county, emerald beryl occurs in a pegmatitic vein. No very large crystals have as yet been found at this locality, but some have been taken out that have cut small gems of a deep emerald color. Matrix specimens of emerald with feldspar, tourmaline or quartz are being cut en cabachon and they make handsome and attractive stones.

The aquamarine variety of beryl is found very commonly in many of the pegmatitic dikes that have been worked for mica. The most important of these are in the vicinity of Spruce Pine, Mitchell county, at the Ray mine, Yancey county, and the Littlefield mine, Macon county, where transparent aquamarine beryls have been found very abundantly that have cut many beautiful gems. Beside the aquamarine, blue beryl has been found in fine crystals in the mines near Spruce Pine, Mitchell county, so also has the yellow or golden beryl. The Wiseman property near Spruce Pine, Mitchell county, is a promising field for aquamarines and has furnished pieces up to 20 carats in weight. The value of the beryls of all varieties mined during 1901 was \$2,250. Of the beryls found during 1901, the largest aquamarine weighed, when cut, 11 carats, the largest blue beryl, 26 carats, and the largest yellow or golden beryl, 6 carats.

HIDDENITE.

This gem is a variety of the mineral spodumene, a lithium aluminum silicate, and is of a yellowish-green color, due probably to the presence of minute quantities of chromium. Hiddenite has only been found at the emerald locality at Hiddenite, Alexander county. While some of the crystals have a uniform green color, they are generally yellow at one end and graduate through yellowish-green to a green at the other. The hardness of the hiddenite is below that of quartz, being but 6.5 to 7, but on account of its rarity, color, and very brilliant lustre, it ranks at the present time as one of the most expensive gems. The finest crystal that was obtained from this locality measured 2 3-5 inches by $\frac{1}{2}$ inch by $\frac{3}{4}$ inch, with one end of a very

fine green color and would probably afford a gem, if cut, which would weigh about $5\frac{1}{2}$ carats.

QUARTZ.

This mineral is very varied in its occurrence and is found in many colors and forms, furnishing many varieties of gems. The more important of these gem varieties are given below:

Rock crystal has been found in many beautiful transparent crystals and masses from White Plains, Surry county; Hiddenite, Alexander county, and Chestnut Hill, Ashe county.

Smoky quartz or Cairngorn stone is found in quantity in Burke and Alexander counties.

Amethysts of a beautiful deep purple color have been found at a number of localities in the State, principally in Macon, Lincoln and Catawba counties.

Sagenite or Venus Hairstone is crystalline quartz that is penetrated with a net-work of acicular crystals of rutile. Some of the most beautiful specimens of this rutilated quartz have been found in Alexander and Iredell counties. It has also been found in Catawba, Burke and Randolph counties.

Citrine or Spanish topaz is a yellow variety of quartz that has been found in Burke and adjoining counties, but seldom of a rich deep color.

Other quartz gems that have been found in North Carolina are chrysoprase, from Macon county; rose quartz, and morien, from Alexander county; aventurine from Iredell county; chalcedony; agate; jasper; and carnelian. The value of the quartz gems found during 1901 was about \$355.

OTHER GEM MINERALS.

The feldspar that is a constituent of the pegmatitic dikes of Mitchell and Yancey counties, is occasionally met with of good quality for cutting into moonstones and sunstones.

Beautiful crystals of rutile are obtained from Alexander county that have been cut into gems that resemble black diamonds.

Fine blue crystals of cyanite are obtained in Mitchell and Gaston counties. Near Spruce Pine, Mitchell county, some of the finest grass-green cyanite that is known has been discovered.

Staurolite, zircon, spinel, peridot, lazulite, and serpentine are among the other gem minerals that have been obtained in the State.

The total value of gem minerals produced in 1901 was \$24,245 as compared with \$12,020 in 1900. This production was divided as follows:

PRODUCTION OF GEM MINERALS IN 1901.

NAME.	VALUE.
Rhodolite -----	\$ 20,350
Other garnets -----	625
Beryls -----	2,250
Sapphires -----	45
Quartz gems -----	355
Other gems -----	20
Mineral specimens -----	600
Total value -----	\$ 24,245

MONAZITE.*

Monazite, which is essentially an anhydrous phosphate of the rare earth metals cerium, lanthanum and didymium, usually contains a varying but small percentage of thorium and silicic acid, which are very probably united in the form of a thorium silicate. It is the presence of this thorium that gives the monazite its commercial value, and this varies from a fraction of a per cent. to 32 per cent., but the majority of the monazite samples contain from 3 to 9 per cent. of this oxide. The mineral is a light yellow to honey yellow, reddish, brownish, or greenish-yellow in color, with a resinous to vitreous luster, and is brittle, breaking with a conchoidal to uneven fracture. Its hardness is from 5 to 5.5 (being readily scratched by feldspar) and has a specific gravity of 4.64 to 5.3.

OCCURRENCE.

Monazite is found very widely distributed as an accessory constituent in varying proportion in many granites and their derived gneisses; but the commercial deposits have thus far not been found in the original rocks, as they contain but a fraction of a per cent. of this mineral, but are found in the placers of the present streams and

*See also Bulletin No. 9.

rivers and in the old sands and gravel deposits of former streams. By the decomposition and disintegration of these crystalline rocks, which in the Southern States has proceeded to considerable depths, and by erosion, the constituents of these rocks are deposited in the stream beds, the heavier minerals being deposited first and nearer where they originated, and thus the richer deposits of monazite in these placer gravels or sands are found nearer the source of the original rocks. Monazite has been found in the granitic mica gneisses and hornblende gneisses of the South Mountain Region of North Carolina, covering an area of some 2,000 square miles in McDowell, Burke, Rutherford, Cleveland, Polk, Catawba, Lincoln and Gaston counties, and from the alteration and erosion of these rocks have been formed the extensive deposits of these counties which have been the chief sources of all the monazite mined in the United States. These workable deposits are found along the streams that have their sources in the South mountains, and they are Silver, South Muddy, and North Muddy creeks and Henry and Jacobs forks of the Catawba river, in McDowell and Burke counties; the Second Broad river and tributaries in McDowell and Rutherford counties; and the First Broad river and tributaries in Rutherford and Cleveland counties. In recovering the monazite, the sands and gravels are sluiced similarly as placer gold is washed, and, after drying the resulting concentrates, the magnetite, ilmenite, etc., are separated by means of the electromagnet. As the value of the sand depends upon the percentage of thorium, and as this is dependent in turn upon the percentage of monazite in the sand, it is to the producer's advantage to make his sand as nearly pure monazite as possible. One company is erecting a mill near Shelby, Cleveland county, North Carolina, to treat the saprolitic rock containing the monazite, claiming that they can get a purer product than from the placer deposits. From the experiments that they have made, they believe that they can work these decomposed gneisses at a profit.

There are given below the percentages of Thorium (ThO_2) that have been found in some of the commercial monazite sands of North Carolina:

PERCENTAGE OF THORIA (ThO_2) IN NORTH CAROLINA MONAZITE SAND.

	PER CENT.									
	1	2	3	4	5	6	7	8	9	10
ThO_2 -----	2. 18	2. 25	6. 54	1. 27	6. 30	2. 45	5. 87	6. 26	3. 98	1. 93

1. White Bank Gold mine, Burke county.
2. Hall Creek, Burke county.
3. Linebacher Place, Silver Creek, Burke county.
4. Long Branch, McDowell county.
5. Alexander Branch, McDowell county.
6. MacLawrath Branch, McDowell county.
7. Proctor Farm, near Bellwood, Cleveland county.
8. Wade McCurd Farm, Carpenters Knob, Cleveland county.
9. Davis Mine, near Mooresboro, Cleveland county.
10. Henrietta, Rutherford county.

The monazite concentrates obtained from working the saprolitic gneisses is said to contain 7.01 per cent. of thoria. Sand is reported to have been obtained in Burke county that contains 7.28 per cent. of thoria.

As is seen from the above, there is a wide variation in the percentage of thoria in the commercial monazite sands. This percentage can be, in many cases, very materially raised, by more careful washing of the gravels, and using the electro-magnet in the separation of the iron minerals. In some instances the monazite deposits contain more or less gold, so that they can be worked for this metal, leaving the monazite as a valuable by-product.

The thoria contents of the monazite is used in the manufacture of the cylindrical hood or mantle of the Welsbach and other incandescent gas lights. The cerium oxalate, obtained in the separation of the rare earth oxides, is used in pharmacy. There are also very small quantities of lanthanum and didymium oxides used with the thoria in the manufacture of the cylindrical mantles.

There was a considerable increase in the value of the monazite pro-

duced in 1901 over that of 1900, although the amount was less, and was 748,736 pounds valued at \$59,262 as compared with 908,000 pounds valued at \$48,805 in 1900. While this increase in the value per pound of the monazite is partially due to an increase in the price of the sand, it is also partly due to the fact that the production reported is cleaner sand and, therefore, higher in thoria. The actual amount of thoria produced in 1901 is probably fully as much, if not more, than that produced in 1900. The price of monazite received by the original miner varies from $3\frac{1}{2}$ to 5 cents per pound, but the further cleaning to which the material is subjected, increased its value to 8 cents per pound. The larger amount of the monazite was obtained from Burke and Cleveland counties with smaller amounts from McDowell and Rutherford. There is a considerable demand for North Carolina monazite both in this country and abroad, and during the past few months (December, 1901, to February, 1902) a number of representatives of German manufacturers have been in the monazite districts of North Carolina investigating the field with a view to purchasing deposits. One tract of 353 acres is reported to have been bought near Ellenboro, Cleveland county. It is very probable that the production of 1902 will exceed both in value and amount by a considerable figure that of 1901.

In the following table is shown the production of monazite for the past ten years:

PRODUCTION OF MONAZITE IN NORTH CAROLINA FROM 1893 TO 1901.

	POUNDS.	VALUE.
1893-----	130,000	\$ 7,600
1894-----	546,855	36,193
1895-----	1,573,000	137,150
1896-----	30,000	1,500
1897-----	44,000	1,980
1898-----	250,776	13,542
1899-----	350,000	20,000
1900-----	908,000	48,805
1901-----	748,736	59,262

Prior to 1893 there were a few tons per year shipped from different points, but the exact amount is not known. In 1887 the first mona-

zite was shipped from North Carolina, amounting to 24,000 pounds, and was obtained from Brindletown creek, Burke county. By 1893 the monazite industry was well established and continued to increase very rapidly until 1895, when 1,573,000 pounds were produced valued at \$137,150. It was at this time that the Brazilian deposits began to be worked and it at once affected the production in the United States, which dropped to 30,000 pounds. In 1898 the industry began to revive and has gained steadily each year, until once more it seems to be firmly established.

BARYTES.

The mineral barytes does not usually occur in well defined veins except when an accessory mineral in certain metallic veins; but is more often found in a series of pockets, lenses, or seams of varying dimensions. These are more or less in line often following the dip of the rock with which they are associated and this rock is in many cases a limestone. Barite is a heavy white mineral with a perfect prismatic cleavage and is known commercially as barytes. In chemical composition it is a barium sulphate (BaSO_4).

The larger proportion of the barytes mined in North Carolina is sold in the crude state direct to the manufacturers, and but a small part is subjected to any treatment before being sold, beyond the washing off of the attached dirt and soil. In preparing the barytes for use, it is cleaned, crushed and some is bolted and some floated. This flour barytes is used in the manufacture of paper, rubber, paints, and in the preparation of a material that is used to coat canvas sacks in which hams are sold. Only the first grades are used in the manufacture of paints, by mixing with white lead, and it is known as "floated barytes." Where it is too much stained with iron oxide to be available for the above purpose, it is beginning to be used in the manufacture of various barium salts. Experiments are also being made as to its value in the glass industry; but no definite results have thus far been obtained.

The barytes deposits of North Carolina that have been worked the most extensively during 1901 are in Madison county in the vicinity of Marshall, Stackhouse, and Sandy Bottom and Hot Springs. It occurs in small seams and elongated pockets, varying from 3 to 10 feet

in width and is very free from impurities. About $3\frac{1}{2}$ miles southeast of Hillsboro, Orange county, near the Chapel Hill road, this mineral of good quality has been found and is very probably in quantity. This property is now being developed by Mr. T. G. Fry of Goldsboro, N. C. The production of barytes in North Carolina in 1901 was all confined to Madison and Gaston counties and amounted to 7,390 tons valued at \$22,615. There have been many inquiries received during the past year regarding localities where this mineral occurs. This has led to the development of the deposit near Hillsboro, and it is very probable that there will be a considerable increase of the production of this mineral in 1902 over that of 1901.

At the Stackhouse mine, what appeared to be two veins at the surface have with depth come together, making a total width of barytes of over 9 feet. Outcroppings of barytes have been observed on the surface for a distance of 2,200 feet. It is expected that the output of this mine will be largely increased during 1902.

The barytes mined by the Carolina Mineral Company is cleaned and ground at their mill at Marshall, and is the only barytes mined in North Carolina that is thus treated. There are one or two individual operators of barytes in this district, but most of the output is controlled by one company.

Lawson Barytes Mine, near Bessemer City, N. C.—The barytes deposit is located about five miles nearly due south from Bessemer City, Gaston county, a station on the Southern Railway, and is about one mile a little east of south of the north end of the peak of Crowder's mountain. The elevation at the mine is somewhat higher than the railroad at Bessemer City and a perfect graded road could readily be built from the mine to the railroad at a point which would be distant about four miles from the mine.

Crowder's mountain, near which the mine is located, is one of a line of isolated peaks and ridges which stretches from the South Carolina line northeastward, the most noted ones of those peaks being Kings, Crowder's and Anderson mountains. These mountains rise from 500 to 1,000 feet above the average elevation. The country rocks of this district are for the most part crystalline schists and gne-

isses, the former being micaceous, chloritic, argillaceous, and sometimes graphitic; the latter are micaceous. The strike of the schistosity of these rocks is in a general direction northeast, and the dip generally westward at very steep angles. Occasionally lenticular bodies of siliceous, magnesian limestone have been observed, but none were found to the eastward of Crowder's mountain in the vicinity of the barytes deposits, although they have been found to some extent to the westward of this mountain and between it and King's Mountain. Quartzite has been observed as forming the higher ledges of the mountains.

Barytes has been found at a number of points in the vicinity of King's and Crowder's mountain, and occurs in what at first appear to be regular well defined fissure veins between walls of a micaceous, argillaceous schist. The barytes outcrops at intervals and has been encountered by open cuts and pits at numerous points throughout a distance of 2,400 feet. The main deposit, or so-called vein, varies in width, as now exposed in the underground workings, from $2\frac{1}{2}$ to 6 feet and at one point it was observed 12 feet in width. As the deposit was followed down from the surface, it was found to widen from a few inches to a foot to the width mentioned above. To the west of this main deposit there is another, approximately parallel, which, however, is not as wide. There are also small seams of barytes that were observed directly east and west of this main vein and separated from it by narrow bands of schist. About 400 feet to the east another vein that is approximately parallel to the first has been encountered. The strike of the barytes veins is in general approximately north 10° to 15° east and dipping at high angles, usually toward the west. In some places they are nearly perpendicular. As will be noticed, the strike and dip of the barytes correspond closely to the strike and dip of the schistosity of the schist. Where the barytes was encountered near the surface and followed downward, it increased in width; but there was considerable variation in the width as followed along the strike; in two or three instances, where it has been followed along the strike, the barytes narrowed down to a thin seam. At lower levels, however, following the same direction and at

a corresponding point on the strike, the barytes was found to be much wider. This, with the other phenomena noted, would indicate that the barytes is occurring in lenticular masses whose strike and dip are conforming to those of the schist and are pitching toward the south. One of these lenses is at least 400 feet in length, as it has been opened up for this distance by means of drifts; but it is undoubtedly considerably longer.

The barytes very probably represents the filling of fissures and crevices in the schist which may have been caused by the faulting and the tearing apart of the schist. This method of formation of these deposits of barytes would readily account for the finding of the large main veins of barytes and the smaller seams approximately parallel to them. These lenticular veins may be found to be many hundreds of feet in depth and then be connected by a thin seam of barytes with another. Judging from the length of the barytes lenses already observed, it may be expected that they will be followed for a number of hundred feet before they begin to pinch out.

Where the barytes is more or less cracked and seamed, it is badly stained with iron oxide, but with deeper mining this began to grow less. There are some sulphides found associated with the barytes such as galena, and sphalerite; but as far as observed, these have been along certain lines and not scattered through the barytes. In breaking up the masses of barytes which contain these streaks of sulphides, it readily breaks, following these seams, and the sulphides can as a rule be readily eliminated by hand-cobbing with but very little waste of the barytes. By giving a little care to the hand-cobbing of the barytes, by far the larger proportion of the iron-stained barytes, which is due to seams and cracks, can be eliminated. Most of the barytes is free from grit, especially in the wider portions of the deposit, but occasionally along the contact or in the narrower portions, some barytes was encountered that contains grit; but this can readily be kept separated from the first quality of barytes.

It is usually granular in structure, but occasionally masses of some size are obtained that are made up of cleavable blocks. The quality of the barytes, as a whole, is good and by giving some care to its selection, barytes of the first quality can be obtained.

OCHER.

In Henderson county, about $4\frac{1}{2}$ miles southwest of Saluda and one fourth of a mile from the Polk county line, on land belonging to M. M. Staton, there is an ocherous clay that occurs in quantity. This has been used as a paint pigment and is said to give satisfaction. Saluda, on the Southern Railroad, is the nearest point on the railroad and is connected by a good road.

In the vicinity of Tomotla, Cherokee county, ocher has been found to some extent, but sufficiently large deposits have not as yet been discovered that would justify the erection of a plant for preparing it for market. In the vicinity of Wilson's Mills, Johnston county, on the land of Mr. W. G. Wilson, ocher deposits of some promise have been discovered. Mr. C. H. Womble of Glendon, Moore county, has reported the occurrence of yellow ocher near that place, where it is believed to occur in quantity.

Near Rockingham, Richmond county, on land belonging to Mr. Steele, red and yellow ocher of good quality has been found. They make a good pigment, and the property is worthy of further investigation.

TALC AND PYROPHYLLITE.

The demand for talc and the similar mineral pyrophyllite is constantly increasing and this is causing a considerable interest to be centered in the North Carolina deposits of Swain, Cherokee, Moore, and Chatham counties.

The properties of these minerals, that make them suitable for the purposes for which they are to be used, are their extreme softness (being among the softest minerals known); their purity or freedom from grit; their stability; and their smooth, slippery touch. When the talc is of sufficient compactness, it is sawed into pieces of various shapes and sizes; gas tips; and into different styles of pencils. The larger proportion of the talc and pyrophyllite which are mined is ground to a flour, similarly as mica, and used in the manufacture of talcum powder; in wall paper; as the basis of many lubricants; in paper; and in the manufacture of some of the cheaper varieties of soap.

The impure varieties of the mineral talc, which are known as soap-

stone, contain more or less grit and are not as a rule suitable for the purposes enumerated above. It is, however, quarried to a large extent for manufacturing into various soapstone articles, as griddles; boot and shoe dryers; table tops for laboratories, ovens, etc. It is also used to some extent for chimneys and for lining fire-places. For this latter purpose it has been quarried in small quantity at a number of places in the mountain sections of the State.

The talc deposits of Swain and Cherokee counties are found in connection with the marble formation of this section of the State. What was formerly supposed to be a regular vein of the talc was probably a series of pockets of this mineral of varying thickness, lying for the most part directly between the marble and the quartzite, although at times they are entirely enclosed by the marble. None, however, have been observed that were enclosed by the quartzite. These pockets, which resemble in shape flattened lenses, always follow the dip of the strata in which they occur, and are therefore encountered in all positions from horizontal to vertical.

The pyrophyllite deposits are located in the extreme north central portions of Moore and the south central part of Chatham counties, and can be traced across the country for a distance of eight miles. The principal mining that has been done is near the boundary between the two counties in the vicinity of Glendon, Moore county. They are associated with the slates of this region but are not in direct contact with them, being usually separated by bands of siliceous and iron breccia, which are probably 100 to 150 feet thick. These bands of breccia contain more or less pyrophyllite, and they merge into strata of pyrophyllite schist. Between these and the massive beds of pure pyrophyllite there are very often small seams of quartz and larger lenticular quartz masses several feet thick.

The beds of this mineral are not entirely of commercial quality, but there are bands of the pyrophyllite that are highly siliceous alongside of those that are entirely free from grit. Although the general appearance of the waste and good material is very similar, they can readily be distinguished by the touch, and can readily be kept separate by hand cobbing.

The more important talc mines in the State are the Hewitt and Nantahala in Swain county and the Hillyer in Cherokee county. Of the pyrophyllite mines, the Snow, Womble, and Rogers creek are the largest and are all in Chatham county.

PRODUCTION.

As these two minerals are used for the same purposes, their production is given together and in 1901 it amounted to 5,819 tons valued at \$77,824. This is an increase of 2,319 tons and of \$35,824 in value over the production of 1900, which was 3,500 tons valued at \$42,000. This large increase is due to the re-opening of the Hillyer mine in Swain county, the Snow mine in Moore county and a general increase in the production of the other mines. Besides that above, there was a small amount of soapstone that was quarried for cutting into slabs for chimneys, etc.

The different forms in which this talc was marketed are shown in the following table:

TALC PRODUCTS OF NORTH CAROLINA IN 1901.

	1901.	
	TONS.	VALUE.
Ground talc, for powders, etc. -----	2,864	\$ 29,505
Talc cut into pencils, gas tips, etc. -----	375	26,000
Talc sold crude -----	2,580	22,319
Soapstone cut into slabs for chimneys, etc. -----		150
Total -----	5,819	\$ 77,974

The demand for North Carolina talc is really greater than the supply; and there are other deposits in the talc belt that are worthy of investigation. Notwithstanding the large increase in the production of talc in 1901 over that of 1900, the production of 1902 will probably be still greater.

GRAPHITE.

Graphite commonly occurs in embedded foliated masses and also in granular, compact, and micaceous masses, sometimes as a solid struc-

ture and at other times earthy. It is sparingly found in 6-sided and tubular crystals, and this with the foliated variety has a perfect basic cleavage, the thin laminae that separate being flexible but not elastic. In color it is black to a dark steel gray and has a metallic to sometimes dull and earthy luster and a greasy feel. It varies in hardness from 1 to 2. The chemical composition of graphite is theoretically pure carbon, but it is often impure from the presence of iron sesquioxide, clay, quartz, etc. The properties of graphite that make it especially valuable for the purposes for which it is used in the mechanic arts, are softness, flexibility, low coefficient of friction, conductivity, adhesiveness and exceedingly slow oxidation at high temperatures.

The different grades of graphite are used for different purposes; the best grades, which are practically pure graphite, are used in the manufacture of lead pencils, lubricants and for electrical purposes. The other grades are used in the manufacture of crucibles, stove polish, foundry facings and in the manufacture of paint for metallic surfaces. The largest use of graphite is undoubtedly in the manufacture of crucibles.

The amount of graphite mined in the United States is comparatively small when compared with the amount that is imported. The production of graphite in this country has increased very materially in the past two or three years, but this is also true of the importation, and thus there is a wide opening for graphite mining in this country; and any newly discovered deposit of this mineral that is near the railroad is worthy of investigation. There have been many inquiries regarding the occurrence of graphite in North Carolina by those interested in obtaining deposits of this mineral, and during 1901 considerable attention was given to the investigation of these deposits.

OCCURRENCE.

As a mineral, graphite is widely distributed in nature, occurring in gneisses, mica schists and crystalline limestones, but as an ore deposit, it is found in but few places and occurs in beds and embedded masses and in laminae or scales in these rocks. Schists have been observed impregnated with graphite to such an extent that they become graphitic schists and have been found extending over a number

of miles of territory. Graphite deposits of some considerable promise have been found in Yancey, Mitchell, McDowell, Burke, Catawba, Wilkes and Wake counties. At Graphiteville, McDowell county, an extensive plant is being erected by the Connally Graphite Works to mine and manufacture the graphite that occurs in this section. The deposit consists of an extensive series of bodies of graphitic schists in a country rock of mica schist and gneiss, the schists varying widely in their percentage of graphite. These graphitic schists can be traced for a distance of about 3 to 4 miles in a N. E.-S. W. direction from Brush mountain on the west to Fork mountain on the east. The deposits first became prominent near Mill creek trestle of the Southern Railroad. The schists cross up and down 5 ridges, each of which rise to a height of 500 feet or more above the general level of this section of the country. The aggregate amount of graphite in this deposit is enormous, but it presents certain problems in its purification and the method to be used is one discovered by Dr. J. W. Ihne, who is general manager of the company.

Similar deposits occur in Burke and Wake counties. In the latter county, however, the percentage of graphite is apparently greater, as also the extent of these deposits. These Wake county deposits are found in a belt extending in a N. E.-S. W. direction with about the middle of the belt $2\frac{1}{2}$ miles west of Raleigh. The two more promising properties on this graphite belt belong to the Tucker estate (care of Chas. H. Belvin), Raleigh, North Carolina, and the other to Mr. E. McK. Goodwin, Morganton, North Carolina. The graphite deposit on the former of these properties is first encountered near Method depot on the Southern Railway, and can be traced for 8 or 9 miles toward the northeast, and for two or three miles to the southwest. The best graphite has been found in that portion of the deposit to the north of Method and it has been worked to a limited extent for a number of years. For crucible and foundry purposes this graphite is well adapted. The other property lies just north of the Holly Springs road, about 4 miles from Raleigh and about $2\frac{1}{2}$ miles from Caraleigh Mills, a siding of the Southern Railway.

In Catawba county, graphite deposits 9 miles east and southeast of Newton have been developed to some extent. The principal work

was done nearly 30 years ago. Several shafts were sunk and a considerable quantity of graphite was taken out, cleaned and shipped. Deposits in the same vicinity are now being worked by A. P. Lynch and W. R. Selfand of Newton. They have sunk a shaft 20 feet deep on the deposit and report that a better quality of graphite was encountered in the bottom of the shaft than near the surface.

All the graphite occurring in these deposits is of the amorphous variety and will only make what are called the second and third grade ores, but these grades constitute by far the larger proportion of the graphite used.

One of the most interesting graphite deposits in the State is one in Alexander county, about 5 miles from Taylorsville. The properties upon which this graphite has been found are first encountered about 5 miles a little south of west from Taylorsville on the eastern and northeastern slopes of Barretts mountain, and graphite has been observed at intervals for a distance of over two miles in a direction a few degrees west of south.

The country rocks are schists and gneisses, cutting through which are pegmatitic dikes varying from a few inches to five (5) feet or more in thickness. The graphite occurs in these pegmatitic dikes and is in the form of small particles and nodules from a fraction of an inch to six or more inches in diameter. Wherever these pegmatitic dikes have been observed, they have been badly decomposed and but very little fresh feldspar has been observed in them. The graphite is of good quality, some being of a nearly crystalline character. In the deeper workings there was but little of the graphite stained with iron oxide. On breaking open the nodules of this mineral, they were found to be nearly pure, and on testing them, no grit was observed. The quality of the graphite seems to be uniform wherever encountered along this belt, although, of course, some variation was noted in the percentage of that stained with iron oxide, according as it was found near the surface, or at considerable distance below. There is considerable variation in the percentage of graphite in these pegmatitic dikes, and it will not average over 25 per cent. In some places, however, where the large nodules of graphite were found, the percentage will run as high as 50 or 60 per cent. The graphite is readily

separated from these decomposed dikes, and where it occurs in nodules of an inch or over in size, a product can be obtained by hand-cobbing that is composed of 90 per cent. or over of graphite. No work has been done of sufficient depth so that the unaltered pegmatitic dikes were observed, but in one opening the dikes were observed that were but partially decomposed. If in depth the graphite remains a constant constituent of these pegmatitic dikes, it should be found in a very pure condition as the solid dike is encountered and it should not be a difficult problem at all to make a clean separation of the graphite from the associated minerals of the dike. These pegmatitic dikes are dipping from 30 to 50 degrees northwest and have a general strike a few degrees east of north. They follow for the most part the lamination of the rocks, but sometimes are cutting across them. They vary considerably with width, widening and contracting in short distances.

The occurrence of graphite in pegmatitic dikes is unusual, although it is often found in gneisses and schists, in some places being so abundant in the schist as to form those that are termed graphitic-schists. At only one point was any of the country schist observed that contained any appreciable per cent. of graphite. This was at a small opening on the Will Bentley farm.

The National Graphite Company of Chicago, Ill., are developing a property in Yancey county, but have not as yet done sufficient work to demonstrate what their property contains.

The only graphite mined during 1901 was from the Wake county deposits and amounted to 95 tons valued at \$559.25.

COAL.

The coal deposits of North Carolina are confined to the two narrow areas or belts of Triassic sandstone and shales, which cross obliquely the Piedmont Plateau region and are in general parallel to the mountains and seashore. The larger of these is known as the Deep river belt, which in a general way extends along a trough from Oxford in Granville county, southwestward across the State with a width near its central point of some 15 miles, but narrowing very considerably at each end. The coal of the Deep river belt is limited to a region

extending from the southern part of Chatham county 10 or 12 miles into the northern part of Moore county. There are five seams of coal reported in this belt which are separated by black shales and slates, black-band iron ore and fire clay. These seams of coal vary from 6 inches to 4 feet in thickness, but with a probable workable average of 22 to 24 inches. While this cannot be called an extensive coal field, it does offer possibilities of remunerative coal mining. The principal mines being operated are the Cumnock by the Chatham Coal and Coke Company located at Cumnock, Chatham county.

The Dan river belt, which has a width of from 2 to 4 miles and a length of nearly 30 miles in a N. W.-S. E. direction, extending across Stokes and Randolph counties, does not offer as promising possibilities for coal mining as the Deep river belt. The most promising outcrops for coal are those along the line near the wagon road from Walnut Cove to Germanton, Stokes county. The coal-bearing seam at this point is said to have a thickness of from 2 to 7 feet.

The most serious obstacles in mining these coal deposits are the narrowing and pinching of the coal to thin seams; the variation in quality, the wider beds being very apt to be more slaty; the intersection of the coal beds by trap dikes; and the absence of coal from some portions of the area. For these reasons no large prices have been paid for coal lands in this district; and mining should not be undertaken on any considerable scale until the property has been thoroughly tested by boring. The coal is a bituminous of good quality. For all the coal mined in this district, a local State market can be obtained, and the coal should bring a fair price, if it is kept free from slaty material, for the coal has a good reputation. When undertaken conservatively, the mining of this coal should make a profitable but small investment.

The Cumnock mines of the Chatham Coal and Coke Company at Cumnock continue to be the largest producers of coal. A new property of 625 acres is being developed by E. D. Steele of High Point, North Carolina. It is located one mile from Hora Branch, a station on the Durham and Charlotte Railroad in a horse-shoe bend of Deep river, Moore county. The property has been tested by borings and pits. One hole made $\frac{1}{4}$ of a mile from the northeast boundary of the

property showed the presence of two coal seams, the upper 1 foot 9 inches in thickness, then a seam of slate, and the lower seam 2 feet 8 inches in thickness. Two other holes about $\frac{1}{2}$ a mile southwest of the first showed about the same results. About one-fourth of a mile northwest of the first, another hole was bored which showed 3 feet of soil; 6 feet 10 inches of saprolitic rock; 3 feet of a fire clay; 4 feet 4 inches of slate; and 2 feet 10 inches of good coal. Another property near Eagle Springs, Moore county, is being developed. Samples of coal from this locality were of good quality.

The production of coal in 1901 was 3,723 tons valued at \$5,585 as compared with 18,000 tons valued at \$22,500 in 1900. The value given for the coal is that obtained for it at the mine. If the work is continued on the Moore county deposits the output should be increased during 1902.

BUILDING STONES.

North Carolina is exceptionally well provided with building stones, which are to be found in abundance in the middle and western counties, and include sandstone, granite, marble, limestone, slate and serpentine, which are taken up in the above order.

SANDSTONE.

Sandstones are found in the Triassic sandstone formation that forms one belt of rock in Anson, Moore, Chatham, Wake, Durham and Orange counties, and another in Stokes and Rockingham. Dr. Geo. P. Merrill, connected with the United States National Museum, in speaking of the rocks in this belt says: "The narrow belt of Triassic sandstone already mentioned as passing through this State furnishes fine, compact, light and dark reddish-brown stone of a quality not at all inferior to any of that in the more northern and eastern States." The principal points at which brownstone or sandstone is being quarried are Sanford and Carthage in Moore county; Cumnock, Chatham county; and near Durham, Durham county.

In the western part of Wake county there is good desirable sandstone that is accessible to the railroad. In Anson, in the vicinity of Wadesboro, there are a number of good deposits of sandstone, as at the Frank Hammond, Linchan and Wadesboro quarries. The stone

from all these quarries is homogeneous, fine grained and quite compact, and usually of a reddish-brown color, varying in places from gray to a grayish-brown. Compression tests made on a block of this stone from Wadesboro cracked at 8,000 pounds per square inch, and was crushed at 11,163 pounds. Its chemical composition is as follows:

	PER CENT.
Silica (SiO_2)	69.28
Alumina (Al_2O_3) and Iron Oxides (Fe_2O_3 and FeO).....	13.84
Magnesia (MgO)	.02
Potash (K_2O) and Soda (Na_2O)	6.43

One noticeable feature of this stone, which is characteristic of most of the stone throughout the belt, is that it hardens considerably on exposure. While it works quite easily when freshly quarried, being split, dressed, and carved with ease, on being exposed for some time to the air and sun it hardens and becomes very refractory. This is perhaps due to material held in solution (as lime) by the "quarry water," which acts as a cementing material upon the evaporation of the water.

Moore county has a number of localities where a good quality of sandstone can be obtained; one is about one mile northwest and another one mile southwest of Sanford. The McNeill quarry is about three-fourths of a mile from the court-house at Carthage, and contains a good brownstone deposit that can be easily quarried. During 1901 only a few corner stones and steps were quarried on account of the lack of capital to properly equip the quarry and introduce the stone on the market. The quarries of R. E. Carrington & Co. of Sanford are the ones that have been the most extensively operated during 1901. They produce a good building stone that wears well, and has the following chemical composition:

	PER CENT.
Moisture (H_2O)	0.79
Silica (SiO_2).....	81.59
Ferric Oxide (Fe_2O_3).....	4.38
Alumina (Al_2O_3)	10.81
Lime (CaO)	1.02
Magnesia (MgO)	.33
Potash (K_2O) and Soda (Na_2O).....	1.08

The sandstone deposits of Chatham county are in the vicinity of Gulf and Cumnock (Egypt) and there are a number of localities that offer favorable opportunities for quarrying. Near the village of Egypt there is a bluff rising about 30 feet above Deep river that extends at about the same height for half a mile down the river. The color of the stone is a uniform brownish-red, and it is fine-grained and compact. At Gulf there is a fine-grained red-brown sandstone in a bluff that rises about 25 feet above the river.

The sandstone deposits of Durham county are a few miles north and east of the city of Durham. There are also good deposits in the vicinity of Brassfield in the southwestern corner of the county.

Although at the present time there is but little quarrying being done on the sandstone deposits, it is not because they are not extensive or well adapted for building purposes, but for lack of capital. They are capable of being developed on an extensive scale and when the stone is once introduced into the general market it will give satisfaction and there will be considerable demand for it. There are a number of points favorable to quarrying of this sandstone, as the jointage of this Triassic formation, which eliminates the necessity of heavy blasting. Where these joints are not sufficiently close together, light blasts are necessary and the large blocks loosened are afterwards split up into the desired size by means of plugs and feathers driven into a line of holes marking the desired break. Nearly all of the sandstone is rifted parallel to the bedding planes, but it will be found that it splits nearly equally well in either direction.

The production of sandstone in 1901 was valued at \$11,682 and was used for building purposes; for road making; and ballast. This is a decrease of \$15,528 as compared with the production of 1900, which was valued at \$27,210.

GRANITE.

Granite quarrying is the most extensive of any of the stone trades in the State, and there are numerous deposits of good grades of granite that offer very favorable opportunities for quarrying. Near the city of Raleigh, Wake county, there are a number of quarries that

have furnished a hard, tough, fine-grained, gray gneiss-granite; some of which is favorably located for quarrying and is worthy of investigation. At Wyatt a pink granite is found; and near Rolesville a gray granite occurs abundantly. Twelve miles west of Springhope, Nash county, there are extensive beds of gray biotite-granite of medium grain. In the vicinity of Oxford, Granville county, and Warren Plains, Warren county, a fine light gray granite is to be found that works well. At Greystone, Vance county, a fine-grained gray granite is being quarried. A very pretty mottled porphyritic granite occurs near Lilesville, Anson county. A few miles south of Wilson, Wilson county, there are considerable beds of coarse, red, feldspathic granite, which takes a good polish, closely resembling red Scotch granite.

Building stones are abundant in the higher portions of the Piedmont Plateau region. The more important quarries are in the vicinity of Dunn mountain, Rowan county, 4 to 5 miles east of Salisbury; at Concord, Cabarrus county; Mooresville, Iredell county; and Mt. Airy, Surry county.

The Dunn mountain region is an exceedingly valuable and extensive granite area, which includes Dunn mountain and the adjoining ridge for two miles to the south. It is now being very extensively worked by a number of companies. There are two types of granite obtained from this section; one a medium fine-grained granite of a gray color, and the other, which is similar in texture but has a decidedly pinkish color. The general chemical composition of this pink granite is as follows:

ANALYSIS OF PINK GRANITE FROM DUNN MOUNTAIN, ROWAN COUNTY.

	PER CENT.
Silica (SiO_2)	75.14
Alumina (Al_2O_3)	8.61
Ferric Oxide (Fe_2O_3)	7.42
Manganese Oxide (MnO_2)	Trace.
Lime (CaO)	0.93
Magnesia (MgO)	0.04
Soda (Na_2O)	5.82
Potash (K_2O)	2.57

The Dunn mountain granite makes a good building stone and with the present railroad facilities should be operated upon a much larger scale than at present. A more vigorous and extensive system of advertising will create a larger demand for the stone and it can readily enter into competition in price and quality with granite of other States. This is true also of the Mount Airy and other quarries. The Mt. Airy quarries are perhaps the best known of any quarries in the State and have been the most extensively developed. They are located about two miles east of the town of Mount Airy in a solid hill of granite which rises nearly 130 feet above the surrounding valley. The stone is a nearly white granite of uniform grain and texture, and does not exhibit any iron or other injurious accessories. An analysis of this granite gave the following:

ANALYSIS OF GRANITE, MOUNT AIRY QUARRY.

	PER CENT.
Silica (SiO_2)	70.70
Alumina (Al_2O_3)	16.50
Ferric Oxide (Fe_2O_3)	2.34
Pyrite (FeS_2)	0.09
Lime (CaO)	2.96
Magnesia (MgO)	0.29
Potash (K_2O)	2.45
Soda (Na_2O)	4.56

In Davie county there is a very unique but beautiful stone, called "oblicular granite" that is found at Cooloomee, on property belonging to Mr. Frank Hairston. This granite wears well, takes a good polish, and should prove of value as an ornamental stone. The stone consists of a ground mass of quartz and feldspar in which are imbedded around masses of a radiating green augite which are at times more than an inch in diameter.

In the mountain region the principal quarrying has been in the vicinity of Balfour, Henderson county, and Asheville, Buncombe county. At the Balfour quarry, which is nearly one mile south-east of Stony mountain, the stone is a laminated gneiss which at times contains large plencocrysts of feldspar, and while at present it is being used largely for railroad ballast, it is also being cut in dressed

as well as rough building stones and is giving good satisfaction. The Corn quarry, about one mile northeast of the Balfour, is a nearly white stone which makes a very attractive decorated or front building stone, and is being quarried on a small scale.

There has been a constant increase in the production of North Carolina granite in the past few years and a considerable demand is arising for it outside the State, but which should be very much larger. The total value of all the granite produced in 1901 was \$264,402 as compared with \$257,962 in 1900.

In the following table is given the different uses for which the granite has been used:

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1901.

USES.	VALUE.
Building and monumental purposes -----	\$ 108, 574
Paving blocks -----	10, 662
Curbing and flagging -----	56, 245
Crushed stone for road-making and railroad ballast, etc. -----	89, 425
Total value -----	\$ 264, 906

MARBLE.

Marble occurs very extensively in Swain and Cherokee counties and is associated with the talc deposits described on page 66. The marble varies in color from white to pinkish and bluish. While a great deal of the marble has been too much broken in connection with the folding and general up-lift of the rocks of the region to be available as a building stone, there are, however, a number of deposits in which it is of considerable economic importance. The Kinsey quarry some four miles southwest of Murphy is the only one that has been operated during 1901. The marble here is of a pinkish-white and bluish-gray color to white, and of a uniform texture. There is a very promising deposit near Andrews, Cherokee county, on the property of Mr. C. N. Hickerson, across the river from the railroad depot. The deposit here has been tested by boring at a number of places, and it was found to exist in quantity and to be suitable for

building and ornamental purposes. It is white and bluish-gray in color and some has a very pretty mottled appearance. It is fine-grained and compact, and the white variety gives indications of being available for a statuary marble. Below are given partial analysis of the pinkish marble (1) and bluish marble (2) from the Kinsey quarry and the white marble (3) from the Hickerson deposit:

ANALYSIS OF MARBLE FROM THE KINSEY AND HICKERSON DEPOSITS.

	PER CENT.		
	1	2	3
Insoluble residue	2.90	2.80	1.58
Lime (CaO)	49.10	52.30	32.42
Magnesia (MgO)	3.67	0.50	19.58

The first two represent lime marble and the latter a dolomitic marble. It is very probable that the sample from the Hickerson property was near the contact of the talc deposits or quartzite, for it has been observed that all the marble in proximity to the contact that has been examined was dolomitic in character, but further away from the contact it was more of a lime marble.

Four miles a little north of east of Murphy a little development work has been done during 1901 and a quarry has been opened which it is expected will be producing during 1902. This work has been done by the National Marble Company of Murphy, North Carolina.

In Swain county one of the most promising deposits is the Hewitt quarry, near Hewitt station on the Southern Railroad, and is favorably located for quarrying. Tests made upon this marble have shown it to be of very good quality and well adapted for building, both for outside and inside purposes; and it has a high resistance to disintegration by frost. A partial analysis of this marble is as follows:

	PER CENT.
Silica (SiO ₂)	0.95
Lime (CaO)	52.33
Magnesia (MgO)	1.69
Carbonic Acid (CO ₂)	43.20

This shows the stone be a very pure lime marble.

A very extensive deposit of a dolomitic marble occurs about 10 miles north of Marion, McDowell county. It is fine-grained and in color is usually white, but at times it is distinctly blue. Portions of the stone are well suited for building or ornamental purposes. Its chemical composition is indicated in the partial analysis given below:

ANALYSIS OF MARBLE FROM McDOWELL COUNTY.

	WHITE MARBLE.	BLUE MARBLE.
	PER CENT.	PER CENT.
Silica (SiO_2)-----	0.60	1.40
Lime (CaO)-----	30.29	29.23
Magnesia (MgO)-----	21.22	19.58

Nearly all of these marbles would burn to excellent lime, and as nearly all the lime used in North Carolina is imported, the waste product in quarrying should be utilized for this purpose.

There was no production of marble reported in 1901. Thus far there has been practically no attempt made to utilize the waste marble obtained in quarrying, either for burning to lime or for any other purpose. The National Marble Company expect to utilize their waste marble by making lime.

LIMESTONE.

Limestone is found quite widely distributed in North Carolina and has been quarried to some considerable extent for making lime and also for building and paving purposes. Besides the marbles (metamorphosed limestones) of Cherokee and Swain counties, limestone is found quite extensively in Henderson, Transylvania, Madison and Wake counties. The limestone in Henderson and Transylvania counties is from bluish to a nearly pure white in color and is partially metamorphosed. It occurs in the valley of the French Broad river from near Mill river to above Brevard. Limestone of fair quality is found in the vicinity of Hot Springs, Madison county. The Wake county deposits are in the vicinity of Raleigh.

In the eastern counties, especially New Hanover, an impure lime-

stone occurs that offers possibilities for burning to lime or for use in the manufacture of cement.

The larger proportion of the lime used in North Carolina is brought in from Tennessee and Virginia, and the manufacture of lime from the North Carolina limestone deposits offers a very promising field of investment, for the best quality of lime can be made from the limestone from the western counties, and if the limestone deposits of the eastern counties will make a good lime or cement, they offer good shipping facilities for the manufactured product.

The production of lime in 1901, valued at \$11,963, was obtained from New Hanover, Pender, Wake, Henderson, and Transylvania counties; and was used for the following purposes:

USES OF LIMESTONE MINED IN 1901.

USES.	VALUE.
Building purposes -----	\$ 237. 50
Made into lime -----	3, 688. 00
Road materials, curbing, etc. -----	4, 668. 00
Total value -----	\$ 8, 356. 50

SLATE.

Slate of good quality is found in the vicinity of Egypt, Pittsboro, and Goldston, Chatham county, and near Albemarle, Stanly county. It has also been found in Durham and Alamance counties, but its actual value has not been determined. There was no production of slate during 1901.

SERPENTINE.

Deposits of massive serpentine of a light to dark-green color have been found at a few places in North Carolina and they are in nearly every particular identical with those of Maryland, Delaware and Pennsylvania, which have been worked for building purposes. As far as can be judged from what can be seen of the deposits, they are as well adapted to architectural purposes as those of the Northern States.

The stone is compact and worked easily, but at the same time it is tough and wears well. It takes a fine polish and the dark green and mottled varieties give a very rich effect, while the lighter colors, though somewhat peculiar, are not unpleasing. It is used as both an exterior and interior building stone, but it is better suited and much more effective as an ornamental stone for interior decorations.

There are a number of outcrops of serpentine in Buncombe county between Weaversville and Leicester in a formation that crosses the French Broad river a mile below Alexander. The serpentine here is of first-class quality and its nearness to the railroad makes it a very promising deposit for quarrying. Other deposits which are as large and of about the same quality are on Paint Rock of Ivy creek, Madison county, and on Bald creek, Yancey county. These are, however, at the present time too far from railroad transportation. Another deposit that is worthy of investigation is the one in which the asbestos occurs that is described on page 97. At the bottom of the cut referred to, the serpentine was of good color, hard and compact, and takes a good polish. It is within three-fourths of a mile from the railroad, and water-power is available for sawing the stone.

Thus far no attempt has been made to utilize the North Carolina serpentines, but the Buncombe county and Wilkes county deposits are well worthy of further investigation as to the actual amount of good stone that they are capable of producing. When once this stone has begun to be marketed, there is little doubt but that the demand for it will rapidly increase.

CLAY.

Under this head are included all the clays of whatever character, from the purest kaolin to the most impure brick clay, that have been utilized in any way for commercial purposes. All clays are mixtures of the mineral kaolinite with more or less quartz and other mineral fragments (silicates) oxides, etc.), possessing usually some plasticity when mixed with water; and being capable of becoming converted into a hard, rock-like mass when subjected to a high heat. An absolutely pure clay would be composed simply of this mineral kaolinite and where there are nearly pure masses of this they are known as

kaolin, and they form the more valuable clay deposits. As kaolinite is not an original mineral, so all our clays are the result of the alteration or decomposition of other minerals, which are for the most part feldspars. These feldspars sometimes occur in nearly pure large masses, as in some pegmatitic dikes, the alteration of which have formed some of the finest beds of kaolin. They also form one of the principal constituents of a large class of rocks, as granites, gneisses, etc., which in their subsequent alteration and disintegration have formed beds of clay. This change that takes place in the minerals of the rocks is due largely to percolating waters containing oxygen and carbon dioxide which are able to penetrate into the most remote cracks and crevices of the rocks and thus under pressure, attack the different minerals. In the case of these feldspars, which are essentially potassium and sodium aluminum silicates, the alkalis (sodium and potassium) are removed in the form of carbonates, while the remaining alumina and silica are hydrated, forming the mineral kaolinite. Where the feldspar occurs in large vein-like masses, the result would be beds of nearly pure kaolin, but where it is a constituent of some large rock mass, the resulting product is one of the impurer clays.

This resultant clay materials may be deposited at or very close to the place where they originated, when they are known as residual clays; or they may have been washed down and deposited in ponds, lakes and seas as sediment, with the addition of other mineral substances, when they are known as sedimentary clays. The residual clays are of a sandy nature, and because of their porosity more care is required in burning them. They often contain many angular grains and fragments of wholly or partially decomposed mineral matter; and the banded structure of the original rock from which the clay originated can often be observed extending up into the clay. Residual clays are to be found all over the Piedmont Plateau and mountain regions of the State, and their thickness depends upon the depth to which the alteration of the rocks from which they have been derived, has extended; and also on the slope of the land.

Sedimentary clays generally make a smoother, denser brick, and one which burns at a lower temperature. These are commonly found

underlying the terraces along rivers, or else in the bottoms of the valleys, where they represent the remains of deposits of sediment in old lakes and ponds. These are found in the Coastal Plain region as well as the Piedmont Plateau and mountain regions.

North Carolina is well supplied with clays of all descriptions, and especially of residual clays, and the great quantity of these has had a somewhat injurious effect upon the clay industry for the reason that in the erection of many cotton mills and other buildings, the contractor has tried to utilize the nearest bed of residual clay (the more siliceous the better he likes it) in the manufacture of the brick for the buildings. Sometimes a good brick would be made, more often a poor one. This is due sometimes to a poor clay, but it is more often due to the contractor trying to make the brick at a minimum amount of labor and expense. Frequently brick are used, the contents of which will hardly stick together. The clays for making common building brick and pressed brick are just as important and should be given as much care as stoneware clay and china clay (kaolin).

The clays can be treated to advantage by taking them up under the following heads: Kaolin, or China Clay; Pottery Clay; Fire and Pipe-clay; and Brick-clay.

KAOLIN OR CHINA CLAY.

Kaolin has been found in a number of widely separated localities in North Carolina, especially in the mountain region, in the form of extensive veins or dikes which were formerly composed largely of feldspar, but which have decomposed from the action of atmospheric agencies and formed this clay. Associated with the kaolin there is always some quartz and mica which were original constituents of the dike or vein. The best kaolin deposits are those in which the feldspar formerly largely predominated in the dike. These dikes vary considerably in size, ranging from a few inches to several hundred feet in thickness and up to several hundred yards in length. They are usually parallel to the schistosity of the crystalline rocks. At the present time kaolin is being mined at a number of places in the vicinity of Webster, Sylva and Addie, Jackson county, and Bryson

City, Swain county. The kaolin deposit that has been worked the most extensively is the one near Webster and known as the Harris mine. This has been worked to a depth of 120 feet, below which point the material becomes harder and does not permit of cheap mining operations. The dike in which this mine occurs has a thickness of nearly 200 feet and has been traced across the country for a distance of more than half a mile. Similar but smaller kaolin dikes are common throughout the Mountain and Piedmont plateau regions, but in order to be successfully worked they must be near railroad facilities.

There is a promising deposit of kaolin near West's Mill, Macon county, on the land of Geo. Brindel. It is of remarkable whiteness; burns to a pure white color; is very fine-grained, free from grit, and shows a few scattered scales of mica. There is also a promising prospect near Liberty Church, Cowee valley. These deposits are at the present time too far from railroad facilities to be of commercial value, but with the advent of the proposed railroad from Talulah Falls, Georgia, to Franklin, Macon county, these deposits will be available. The kaolin deposit on the property of the National Abrasive Manufacturing Company near Hall, Jackson county, has been developed to a slight extent and the clay is of a good quality. It gives indications of occurring in quantity, and as it is not far from the railroad, should make remunerative mining. Near Bostick Mills, 14 miles north of Rockingham, Richmond county, there are extensive deposits of kaolin, which are near railroad transportation and are well worthy of further investigation. There are promising deposits of kaolin that are known to occur 4 miles west of Troy, Montgomery county; near North Wilkesboro, Wilkes county; and in Beaver Dam township, 2 miles southwest of Canton, Haywood county, on land belonging to J. B. Rhodarmer, which is of good quality and apparently in quantity as shown by a shaft 18 feet deep that has been sunk on the deposit.

The most noticeable change that has occurred in the kaolin industry in the State during 1901 is the opening of the mines in Swain county and the erection of a plant for cleaning and preparing the kaolin for market. The Harris mine is still the largest producer of

kaolin in the State and is located near Webster, Jackson county. There was a considerable increase in the production of kaolin in 1901 which was 15,575 tons valued at \$119,171.83 as compared with 7,000 tons valued at \$62,440 in 1900. This increase is partially due to the opening of the Swain county mines. The above figures are for both the washed kaolin prepared for market, and the raw kaolin sold during 1901. There is a good demand for this North Carolina kaolin at the present market price of \$8.50 to \$9.50 per ton, numerous inquiries being received for information regarding the location of kaolin deposits.

The kaolins of North Carolina, where they contain less than one per cent. of ferric oxide, are well adapted to the manufacture of white earthenware or china; and also of the best grades of porcelain. Where the percentage of ferric oxide is from 1 to 2 per cent., the kaolin could probably be used for the lower grades of white earthenware, while those containing from 2 to 2½ per cent. of this oxide could perhaps be used to advantage by mixing with fire clays in the manufacture of refractory apparatus.

POTTERY CLAYS.

There has been but little development of the pottery industry in North Carolina, and although there are 40 or more potteries in the State, they are all small and for the most part are making inferior grades of ware. By far the larger proportion of the earthenware and stoneware used in the State is imported, while it should be manufactured at home. There are plenty of clays suitable for this purpose, which are the finer aluminous sediments underlying the river terraces and which are found in many of the broader valleys, the better clays being usually found near the shore line of the terraces. In using the term pottery clay, it is meant to include those clays that are used to make the lower grades of earthenware and stoneware, the higher grades of pottery being made from kaolins. In the manufacture of common earthenware, which would include flower-pots, almost any red burning plastic clay that permits turning on the potter's wheel and burns to a good red without vitrifying, can be used. In the manufacture of stoneware a better quality of clay is required

and the requisites for such clays are that they should possess good plasticity in order to permit molding or turning without cracking; their tensile strength should be not less than 125 to 150 pounds per square inch; they should not shrink excessively in burning; and should burn to a dense vitrified body, if possible, at a temperature of 2,000 degrees to 2,100 degrees F. They should permit of rapid drying and be as smooth and free from grit as possible. Such clays are found underlying the terraces along the Catawba river north of Morganton and Mt. Holly, Burke county, and near Blackburn and Catawba, Catawba county; the South Fork of the Catawba river, just north of Lincolnton, Lincoln county; the Yadkin river near Wilkesboro, Wilkes county; and Elkin, Surry county; including the old terraces of the Deep river near Ulah and Why Not, Randolph county. In the eastern part of the State along the Cape Fear river near Fayetteville, Cumberland county; the Neuse river near Goldsboro, Wayne county; and Contentnea river, a tributary of the Neuse, in Wilson county, near Wilson, are similar deposits of clay.

There have been 43 pottery manufacturers who responded to inquiries regarding the amount of pottery made by them in 1901 and they reported a total production of \$22,495, which is an increase of \$3,632 over the production of 1900, which was valued at \$18,863. The production of 1901 was divided as follows: For earthenware, \$4,490; stoneware, \$17,453; and decorative ware, smoking pipes, etc.; \$552, as compared with \$1,937 of earthenware; \$16,498 of stoneware; and \$428 of decorative ware in 1900.

While there has been this increase in the value of the production of pottery in 1901, it does not begin to represent the value of what should be produced in the State. With the application of the improved methods, with more care, and by using better material for glazing the ware, the North Carolina potter would be able to put a far better grade of pottery on the market, which would sell at a correspondingly increased price.

In the following table is given a statement of the value of the pottery products by counties and of the value of the earthenware, stoneware and decorative ware made in each county:

VALUE OF THE POTTERY PRODUCTS OF NORTH CAROLINA BY
COUNTIES IN 1901.

COUNTY.	EARTHEN- WARE.	STONEWARE.	DECORATIVE WARE, ETC.	TOTAL.
Buncombe -----	\$ 220	\$ 3, 100	\$ -----	\$ 3, 320
Catawba -----		2, 540		2, 540
Chatham -----		2, 700		2, 700
Cumberland -----	60			60
Johnston -----	525	1, 700		2, 225
Lincoln -----	2, 500	2, 000	25	4, 525
Randolph -----	860	3, 173	200	4, 233
Union -----	325	1, 040	27	1, 392
Warren -----			300	300
Wilkes -----		1, 200		1, 200
Total value -----	\$ 4, 490	\$ 17, 453	\$ 542	\$ 22, 495

As is seen from the above table, the pottery products are confined for the most part to stoneware and that the amount of decorative ware or fancy ware is extremely limited.

FIRE CLAY AND PIPE CLAY.

There are but few known occurrences of deposits of fire clay in North Carolin. The main point desired in a fire-clay is a refractory character and it should also possess good plasticity, low shrinkage, and should be unaffected by a temperature of 2,500 degrees F. (although brick are sold as fire brick which are affected by a temperature of 2,100 degrees F.). Such clays are known to occur at Pomona, Guilford county; Grover, Cleveland county; and Emma, Buncombe county. A clay has also been reported from Cherokee county, about 4 miles east of Murphy, that is suitable for making fire brick and also one near Wilson's Mills, Johnston county. The fire clay from Emma, N. C., has recently been tested by Dr. Heinrich Ries, who heated it to a temperature of about 3,000 degrees F. and it only showed the very finer particles to have been attacked and viscosity occurred at a temperature of 3,250 degrees F. These tests show the clay to have qualities that adapt it for manufacturing into fire brick. The company

operating the clay deposits at Emma expect to increase their plant so that they can manufacture fire brick.

There were not many fire brick made during 1901, and they were valued at \$550, as compared with a production valued at \$714 in 1900.

The requisites desired in clays for the manufacture of sewer pipe are that they should be plastic to permit molding without cracking; have a tensile strength of 125 to 150 pounds; burn to a dense, hard, impervious body of a red or deep red color, and dry and burn with rapidity without the ware warping or cracking. The principal manufacturers of sewer pipe and tile is the Pomona Terracotta Company at Pomona, Guilford county, North Carolina, and they have been constantly increasing the production of their plant. This plant illustrates what can be done with the clays of North Carolina when they are worked on a large scale and by improved methods. The value of the total production of sewer pipes, tile, etc., produced in 1901 was \$55,745.05 as compared with \$54,796 in 1900.

BRICK CLAY.

There are in the greater number of the counties throughout North Carolina clay deposits that are suitable for the manufacture of brick, and they consist of both residual and sedimentary clays. These clays vary in composition both with the character of the rocks from which they have been formed and with the extent to which the materials and the original rocks have been separated by the sorting action of water in transporting these from one place to another. They are usually of a reddish or yellowish color, due to the presence of iron oxide. Although there is a great deal of work being done on the brick clay deposits throughout the State, it is for the most part confined to the manufacture of common brick and there is but little attention being given to the manufacture of pressed, front, or fancy brick. This is not because the clays are not adapted to the manufacture of these brick, for there are many clay deposits that are capable of being made into an excellent pressed or front brick, as those near Asheville, Buncombe county, Wilkesboro, Wilkes county, Goldsboro, Wayne county, etc. Many of these places are at the intersection of several

lines of railroad so that the products would have good railroad facilities for shipment. When it is considered that the larger proportion of the pressed and fancy bricks used in this State are now being imported, it will be seen that there is good opportunity for the development of this branch of the clay industry in North Carolina. Even in the manufacture of common brick the industry is not what it should be, for in many cases the crudest methods are used in their manufacture, and sufficient care is not taken in burning them, so that the result is often a brick of poor quality that will not stand shipment. This also means that a lower price is obtained for the brick. With such favorable opportunities as are offered for making brick in many places in North Carolina, there should be a large increase in their production, especially of fancy and pressed brick; and in a better quality of common brick.

The number of brick made in North Carolina during 1901 was 135,566,570 valued at \$710,680.84, this being an average value of \$5.22 per thousand. This is a decrease of 13,051,430 brick, and of \$30,922.84 in value as compared with the production of 1900, which was 148,618,000 brick valued at \$741,602. The lowest value recorded for brick was \$2.33 per thousand and the highest \$10, except in one instance, when \$20 per thousand was reported for a special vitrified brick. The highest price recorded as having been received for common brick was \$8 per thousand. There were in all 231 manufacturers engaged in making brick during 1901, who made replies regarding their production. In the following table is given the total number of and value of brick produced in 1901 by counties and also the number and value of common brick, pressed brick, and vitrified or paving brick.

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA DURING 1901.

COUNTY.	Common Brick.	Value.	Pressed Brick.	Value.	Vitrified Brick.	Value.
Alamance	4,408,000	\$ 21,665.00		\$		\$
Anson	600,000	3,000.00				
Beaufort	1,695,000	10,480.00				
Bertie	575,000	2,850.00	30,000	240.00		
Bladen	450,000	2,250.00				
Buncombe	2,084,250	10,594.80	200,000	2,400.00		
Burke	1,075,000	4,600.00	25,000	200.00		
Cabarrus	3,050,000	15,250.00				
Caldwell	1,570,000	6,410.00				
Carteret	450,000	2,425.00				
Catawba	845,000	4,050.75				
Chowan	1,000,000	7,000.00				
Cleveland	1,500,000	8,100.00				
Columbus	2,400,000	12,450.00				
Craven	3,250,000	16,750.00				
Cumberland	1,500,000	7,500.00				
Davidson	1,560,000	7,400.00				
Davie	2,500,000	15,000.00				
Duplin	237,000	1,306.00				
Durham	8,425,000	40,275.00	10,000	100.00		
Edgecombe	3,465,000	20,270.00				
Forsyth	10,492,000	48,206.00				
Franklin	500,000	3,500.00				
Gaston	3,150,000	15,630.00				
Gates	100,000	425.00				
Granville	1,250,000	6,250.00				
Greene	1,101,086	6,653.48				
Guilford	10,238,000	53,025.75	170,000	1,700.00	100,000	750.00
Halifax	2,160,000	12,460.00	100,000	1,000.00		
Harnett	1,000,000	5,600.00				
Haywood	500,000	2,500.00				
Henderson	2,950,000	14,325.00				
Iredell	1,907,000	8,885.00				
Jackson	3,000	18.00				
Johnston	1,435,000	8,350.00				
Lenoir	2,500,000	13,000.00				
Lincoln	450,000	2,250.00				
McDowell	1,100,000	6,300.00				
Martin	55,000	328.00				
Mecklenburg	7,485,000	41,062.00				
Montgomery	50,000	20.00	190,000	1,130.00		
Moore	1,635,050	10,220.00				
Nash	6,420,000	24,100.00				
New Hanover	1,000,000	3,000.00				
Orange	825,000	4,345.00				
Pasquotank	1,700,000	10,200.00	25,000	250.00		
Person	600,000	3,000.00				
Pitt	320,263	1,794.73	100,000	1,000.00		
Randolph	697,571	2,942.02	25,000	150.00		
Robeson	1,545,000	8,689.00				
Rockingham	860,000	3,850.00				
Rowan	3,760,000	18,400.00				

COUNTY.	Common Brick.	Value.	Pressed Brick.	Value.	Vitrified Brick.	Value.
Rutherford	1,602,000	\$ 7,783.00				
Sampson	425,000	2,350.00				
Scotland	1,000,000	5,000.00				
Stanly	300,000	1,500.00			50,000	500.00
Surry	1,565,000	7,125.00	90,000	750.00		
Transylvania	187,000	875.00				
Union	2,304,000	11,415.00				
Vance	100,000	700.00				
Wake	3,977,400	22,357.31	50,000	500.00		
Warren	150,000	750.00				
Washington	300,000	1,800.00				
Wayne	7,550,000	39,450.00			10,000	200.00
Wilkes	585,000	2,865.00	30,000	300.00		
Wilson	2,950,000	17,700.00	50,000	400.00		
Yadkin	63,000	315.00				
Total	134,441,570	697,860.84	1,095,000	10,220.00	180,000	1,650.00

Of the 97 counties in North Carolina all but 31 reported some production of brick. The largest number of brick were made in Guilford county and amounted to 10,238,000 valued at \$53,025 or \$5.07 per thousand. Jackson county produced the smallest number, which amounted to 3,000 bricks valued at \$18.

In the following table are given the value of the clay products produced in 1900 and 1901:

VALUE OF CLAY PRODUCTS OF NORTH CAROLINA IN 1900 AND 1901.

	1900.		1901.	
	Quantity.	Value.	Quantity.	Value.
Common brick	148,177,000	\$ 737,577.00	134,441,570	\$ 697,860.84
Pressed brick	441,000	4,025.00	1,095,000	10,220.00
Vitrified brick			180,000	1,650.00
Fire brick		714.00		550.00
Earthenware		1,937.00		4,490.00
Stoneware		16,498.00		17,453.00
Decorated ware		428.00		552.00
Sewer-pipe, etc.		54,796.00		55,745.05
Kaolin	7,000 tons	62,440.00	15,575 tons	119,171.83
Fire clay			33½ tons	100.00
Total value		\$ 878,415.00		\$ 907,789.72

In the aggregate the clay industry in the State becomes an important one, but there is still much room for improvement, and not only should the actual production be greater, but still more so should the value of the production increase. The above statistics regarding the clay production of the State do not represent the entire production, for there have been a number of the producers of clay products that have been very reticent in responding. This has not only caused the statistics regarding clay products of the State to appear lower than they should, but it also reduces the value of the mineral production that is given under the head of the different counties. It is to be hoped that another year those interested in the development of the different mineral products of the State will be more prompt to send in their statistics.

OTHER ECONOMIC MINERALS.

There are a number of minerals that are found in quantity in North Carolina that have a commercial value, but are not being mined at the present time. There are still others which give indications of occurring in quantity and are worthy of further investigation. A brief description is given of the more important of these minerals, including their uses, value, modes of occurrence, etc.

CHROMITE OR CHROMIC IRON ORE.

Chromite is a mineral that usually occurs massive with a fine granular to compact structure. When crystallized it is usually in small octahedrons. It is brittle, breaks with an uneven fracture and has a hardness of 5.5, which is about the same as hard steel. In color it varies between iron-black and bluish-gray and has a sub-metallic to metallic luster. Its theoretical chemical composition is represented by the formula $\text{FeO Cr}_2\text{O}_3$, a combination of chromium sesquioxide and iron protoxide; but it is usually found that a portion of the iron is usually replaced by varying amounts of magnesium and the chromium by aluminum.

The uses of this mineral are in the production of the salts chromate and bi-chromate of potash which are used particularly in dyeing and in the manufacture of coloring pigments; in the manufacture of ferro-chromium alloys which are used very extensively in the manu-

facture of chromium steel. The mineral itself is being used in the manufacture of brick for use in basic open-hearth furnaces. It is also being used directly for linings of various furnaces and where used has given satisfaction. In this connection it is used as a lining for furnaces for smelting copper and this should make the North Carolina ores valuable for the Ducktown, Tennessee deposits and the Gold Hill, Ore Knob, and Blue Wing deposits of North Carolina.

The value of a chrome ore depends upon the percentage of chromic oxide (Cr_2O_3) that it contains, standard ore containing 50 per cent. of this oxide. For every unit above 50 per cent. there is an increase in value of 75 cents to \$1 per ton; but below 50 per cent. there is a much greater deduction per unit. Ores low in silica are the more valuable, and even when they contain but 45 per cent. of the chromic oxide they find a market if they are low in silica.

With the exception of alluvial deposits, chromite has been found only in peridotites and allied igneous basic magnesian rocks or in serpentines which have resulted from the alteration of these rocks. In the alluvial deposits at the base of these rocks there is usually a considerable amount of chromite in crystals and small particles and in certain localities they have been observed in sufficient quantity to constitute a chrome sand ore. In the North Carolina peridites chromite occurs more commonly in grains or crystals and also in embedded masses near the boundary of the lenticular masses of these rocks. The general character of the chrome ore is nearly uniform throughout the entire area, being very hard and compact, though often of a fine granular appearance, and there is but little that is at all friable. The masses of chromite are usually very free from seams containing peridotite or its alteration product serpentine and a high grade ore can usually be obtained by hand-cobbing.

While chromite is found almost universally associated with the peridotites of North Carolina, it is only in a few localities that it occurs in quantity and a brief description of these is given below. One of the most promising deposits in the State is in Yancey county at Mine Hill on Mine Fork of Jack's creek, alongside of the Bakersville road, 5 miles north of Burnsville, the county-seat. The ore occurs in a large peridotite formation which outcrops on both sides

of the road. What little work has been done on this deposit gives indication that chromite occurs in quantity. With the completion of the railroad from Erwin, Tennessee, to Marion, North Carolina, this deposit should become available for commercial purposes. An analysis of a selected sample of this chromite showed 58 per cent. of chromic oxide, but judging from the character of the ore, a 52 per cent. ore can probably be readily obtained by hand-picking and cobbling. This property is owned by Mr. Garrett Ray of Burnsville.

Associated with the large peridotite area or formation in the vicinity of Webster, Jackson county, chromite has been found quite abundantly at a number of points near the contact of the peridotite with the country rock. The principal work has been done on the lands of David Schneider, Joseph Hooker, Lawrence Buress, Alf. Wilson, James Ashe and Daniel Fulbright, all of Webster, North Carolina. The work done shows the presence of a considerable amount of chromite, but it is not sufficient to demonstrate whether it is to be found in sufficient quantity to make profitable mining. These chromite deposits would be from 3 to 5 miles from the railroad.

Another property that is being developed is on Big Ivey Creek in Buncombe county, about 16 miles northwest of Asheville, and 9 miles from the railroad. There is considerable chrome sand on the property, which is readily concentrated, and, as reported, the concentrates contain 54.09 per cent. of chromic oxide. The rock ore, which had been hand-cobbed, gave on analysis 48.78 per cent. of chromic oxide. This property is being developed by Mr. F. L. Plaisance of Asheville.

A promising deposit of chromite occurs in the Balsam Gap peridotite area and is located on both sides of Dark Ridge creek about 175 yards to the south of the Dark Ridge trestle of the Murphy branch of the Southern Railroad. A number of open cuts and pits have been made which show the presence of chromite in some quantity. There is a large quantity of float ore in the vicinity which, with a nearness to the contact of the peridotite and gneiss and the pockets and veins already uncovered, point to this locality as a promising one for further development; and its nearness to the railroad is also greatly in its favor.

All North Carolina ores are high grade, but the existence of large deposits have not as yet been conclusively shown; but the four localities mentioned above are worthy of further investigation.

ASBESTOS.

There are two minerals that are mined and put on the market as asbestos which are very similar in their physical properties, but are distinct chemically. One, a variety of the mineral amphibole, is a silicate of calcium and magnesium and the other a variety of serpentine known as chrysotile, a hydrous magnesium silicate. Both these varieties of asbestos are equal in their heat-resisting properties, but the chrysotile is superior in strength and elasticity of fiber to any variety of amphibole asbestos. The former is usually greenish-white, green to yellowish in color with a decidedly silky luster, while the other is from white to greenish and woody-brown in color and has more the appearance of flax. The fibers of the chrysotile asbestos vary from 1-16th to 3 inches in length while fibers of amphibole asbestos have been found three feet in length. The two varieties can readily be distinguished from each other by testing them for water, the chrysotile being a hydrous mineral and giving off a considerable amount of water when heated. The occurrences of these two varieties are distinct, the amphibole variety being usually found in granitic or schistose rocks, sometimes in pockets and again in well defined veins, while the chrysotile variety is found in seams of varying width, always in serpentine rocks. On account of the many more purposes for which the chrysotile asbestos can be used than the amphibole variety, there is a correspondingly larger demand for this variety.

Where asbestos is used as an ingredient in fire-proof paints, for wall plasters, for packing in the manufacture of fire-proof safes, in the manufacture of boiler coverings and for all purposes where its non-conductivity of heat is the important factor and not the strength of fiber, the amphibole variety can be used and gives as good satisfaction as the chrysotile. On the other hand, however, where the strength of fiber as well as non-conductivity of heat is desired, it is the chrysotile variety that is used, such as in the manufacture of cloth, roping, felt, boards, tubes and washers.

There are a number of localities in North Carolina where the chrysotile variety of asbestos has been found, the most promising of which are in the vicinity of Glenmville and of Sapphire, Jackson county, near the mouth of Squirrel creek of North Toe river, along the western slopes of Rich mountain in Watauga county; on Elk creek in Ashe county; and near North Wilkesboro, Wilkes county. At these localities fiber of fair length and fineness has been found which warrant further investigation.

The deposit near North Wilkesboro is within $\frac{3}{4}$ of a mile of the railroad and occurs in a serpentine formation that is from 75 to about 200 feet in depth and can be traced in a general N. W.-S. E. direction for nearly 600 yards. The deposit has been worked by means of an open cut 100 feet long which was made on the land of Mr. J. B. Church. The cut varies in depth from 1 to 35 feet and near the surface the serpentine encountered was badly decomposed and altered, but at lower depths a compact, dark-green rock was found. This harder rock is similar to a bold outcropping of the serpentine that occurs on a low hill about 300 yards a little east of south of his cut. A similar outcrop of serpentine was observed on the summit of a hill 200 yards nearly north of the cut. In nearly all of this serpentine small seams of the chrysotile asbestos were observed that varied in width from a quarter of an inch to some that were encountered in the bottom of the cut that were nearly two inches wide. These seams run at all angles through the rock and, as the unaltered serpentine was encountered, the asbestos became of better quality. Sufficient work has not been done to demonstrate the actual value of this property as a source of asbestos, but it is worthy of further investigation.

The amphibole variety of asbestos has been found in quantity at a number of localities; near Plumptree, Mitchell county, and on Ellijay creek, Macon county, but on account of their distance from the railroad they have not been able to be worked. There is a very promising locality of this variety of asbestos found on Tryon mountain, Polk county, about $1\frac{1}{2}$ miles west of Skyuka, which has been traced across the country for nearly a mile. It occurs apparently in a series of pockets, one of which was opened and measured nearly 100 feet in width. It is of fair quality and large masses have been taken out

in width. It is of fair quality and large masses have been taken out where the fiber was from 10 to 15 inches in length. This property is owned by Mr. D. Stern, Lynn, North Carolina.

ZIRCON.

Zircon, a zirconium silicate (ZrSiO_4), is commonly found in square tetragonal prisms terminated by the pyramid, and is usually of a grayish, light brown to a reddish-brown color. It is 7.5 in hardness and has a specific gravity of about 4.65. It is commonly found sparingly in crystalline rocks, especially granular limestone, chloritic and other schists, gneiss, syenite and granite. It has also been found associated with some of the iron ores. The use that has been made of this mineral is for a source of zirconia (ZrO_2), which is used in the manufacture of cylindrical hoods or mantles for certain of the incandescent gas lights. At the present time there is but little of this mineral that is being mined except for experimental purposes. There is one noted locality in North Carolina where this mineral has been found in quantity and this is in the vicinity of Zirconia, Henderson county. The zircons occur in what is apparently a decomposed pegmatitic dike about 100 feet wide and with a strike nearly 50 degrees east. The upper portion of the dike is badly kaolinized which permits an easy separation of the zircon which was done by hydraulic processes. As the vein became more solid it is more difficult to separate out the zircon. They are, however, readily detached from the feldspar matrix as this is broken up. There are two mines on these deposits, one the Jones zircon mine half mile west of Zirconia railroad station and the other the Freeman zircon mine which is one mile west of the Jones. From the work done at these mines, it seems very probable that if the demand does arise for zircon in quantity, that a constant supply can be obtained from these mines. Another promising locality for zircon is near New Stirling, Iredell county.

During 1901 there were about 75 pounds of this mineral valued at \$15 sold for experimental purposes.

SUMMARY.

The statistics of the mining industry for 1901 show a decided increase in the production of those minerals that are principally mined in the State; and those which show a less production than of the year

before are those whose production is necessarily limited, either because of location or small deposits. The past year has not only seen more values taken out of the mineral deposits of the State than for a number of years past, but has also seen more money invested in thorough and competent development work than ever before. This means that the mineral production of the State will increase at a rapid rate during the next year or two; and with the successful development and operation of the mines it will mean an additional impetus to bring capital into the State.

Some of the most promising mining propositions that are awaiting investigation and the investment of capital are the clay deposits, which are suitable for the manufacture of pressed and fancy brick and pottery; the large deposits of low grade gold ores, to be treated by the cyanide process; graphite deposits; the granite, marble, sandstone and serpentine deposits; and the corundum mines.

In the table below is given the total mineral production of the State for the years 1900 and 1901:

THE MINERAL PRODUCTION IN NORTH CAROLINA FOR THE YEARS
1900 AND 1901.

MINERAL.	VALUE.	
	1900.	1901.
Gold	\$ 46,653.00	\$ 60,410.71
Silver	15,986.00	34,023.64
Copper	41,600.00	76,900.00
Iron	42,000.00	4,997.00
Pyrite	14,625.00	32,000.00
Corundum	36,840.00	48,840.00
Garnet	18,000.00	43,000.00
Mica { Sheet	65,200.00	79,849.00
Scrap	36,262.00	14,200.00
Quartz	None.	7,500.00
Barytes		22,615.00
Monazite	48,805.00	59,262.00
Talc	42,000.00	77,974.00
Gem minerals, etc.	12,020.00	24,245.00
Graphite		559.25
Coal	22,500.00	5,585.00
Building stones	285,172.00	284,744.00
Kaolin	62,440.00	119,171.83
Clay products	815,975.00	788,617.89
Total value	\$ 1,604,078.00	\$ 1,779,109.32

It will be noticed in the above table that in most cases there has been a decided increase in the production of those minerals for which North Carolina is especially noted, as talc, monazite, kaolin, etc., and that the decrease is for the most part in those minerals, the production of which is not expected to amount to very much in this State. This indicates a healthy condition of the mining industry and should give considerable impetus for a greater amount of mining and development work in 1902, for there is an increasing demand for many of these minerals that are being mined.

This mineral production of 1901 was obtained from 75 counties and the value of this production for each county is given in the table below. The clay products are given separately from the rest of the mineral production whose total value is given.

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH CAROLINA
IN 1901.

COUNTY.	Mineral Production, including Kaolin.	Clay Products except Kaolin.	COUNTY.	Mineral Production, including Kaolin.	Clay Products, except Kaolin.
Alamance -----	\$ 400. 00	\$21,965. 00	Jones -----	\$-----	\$-----
Alexander -----	175. 00	-----	Lenoir -----	-----	13,000. 00
Alleghany -----	720. 00	-----	Lincoln -----	100. 00	6,275. 00
Anson -----	1,800. 00	3,000. 00	McDowell -----	37,074. 00	6,300. 00
Ashe -----	-----	-----	Macon -----	58,180. 00	-----
Beaufort -----	-----	10,480. 00	Madison -----	14,795. 00	-----
Bertie -----	-----	3,162. 00	Martin -----	-----	325. 00
Bladen -----	-----	2,250. 00	Mecklenburg -----	32,149. 00	41,062. 00
Brunswick -----	-----	-----	Mitchell -----	42,835. 06	-----
Buncombe -----	15,090. 01	15,469. 85	Montgomery -----	2,000. 00	200. 00
Burke -----	24,282. 00	4,800. 00	Moore -----	18,796. 00	10,220. 00
Cabarrus -----	22,426. 71	15,250. 00	Nash -----	100. 00	24,100. 00
Caldwell -----	70. 00	6,410. 00	New Hanover -----	4,668. 00	3,000. 00
Camden -----	-----	-----	Northampton -----	-----	-----
Carteret -----	-----	2,425. 00	Onslow -----	-----	-----
Caswell -----	-----	-----	Orange -----	-----	4,345. 00
Catawba -----	-----	6,710. 00	Pamlico -----	-----	-----
Chatham -----	5,585. 00	2,700. 00	Pasquotank -----	-----	10,450. 00
Cherokee -----	27,500. 00	-----	Pender -----	600. 00	-----
Chowan -----	7. 00	0. 00	Perquimans -----	-----	-----
Clay -----	9. 00	0. 00	Person -----	47,000. 00	3,000. 00
Cleveland -----	17,532. 00	8,100. 00	Pitt -----	-----	1,794. 73
Columbus -----	-----	12,450. 00	Polk -----	300. 00	-----
Craven -----	-----	16,750. 00	Randolph -----	20,165. 00	7,377. 02
Cumberland -----	-----	7,560. 00	Richmond -----	-----	-----
Currituck -----	-----	-----	Robeson -----	-----	8,689. 00

COUNTY.	Mineral Production, including Kaolin.	Clay Products except Kaolin.	COUNTY.	Mineral Production, including Kaolin.	Clay Products, except Kaolin.
Dare -----	\$ -----	\$ -----	Rockingham -----	\$ -----	\$ 3,850.00
Davidson -----	2,500.00	7,400.00	Rowan -----	126,438.15	18,400.00
Davie -----	15.00	0.00	Rutherford -----	8,989.64	7,783.00
Duplin -----	-----	1,306.00	Sampson -----	-----	9,100.00
Durham -----	-----	40,275.00	Scotland -----	-----	5,000.00
Edgecombe -----	-----	20,270.00	Stanly -----	2,660.16	2,000.00
Forsyth -----	3,906.00	48,206.00	Stokes -----	-----	-----
Franklin -----	-----	3,500.00	Surry -----	88.65	54.00
Gaston -----	42,279.50	15,630.00	Swain -----	40,115.00	-----
Gates -----	-----	425.00	Transylvania -----	1,440.00	875.00
Graham -----	-----	-----	Tyrrell -----	-----	-----
Granville -----	-----	6,250.00	Union -----	-----	12,807.00
Greene -----	-----	6,653.48	Vance -----	18,700.00	700.00
Guilford -----	-----	110,974.00	Wake -----	21,034.25	22,357.31
Halifax -----	-----	13,460.00	Warren -----	-----	1,050.00
Harnett -----	-----	5,600.00	Washington -----	-----	1,800.00
Haywood -----	13,124.00	2,500.00	Watauga -----	-----	-----
Henderson -----	13,169.43	14,325.00	Wayne -----	-----	39,450.00
Hertford -----	-----	-----	Wilkes -----	-----	5,465.00
Hyde -----	-----	-----	Wilson -----	-----	17,700.00
Iredell -----	70.00	8,885.00	Yadkin -----	-----	315.00
Jackson -----	163,641.93	18.00	Yancey -----	33,995.00	-----
Johnston -----	-----	10,575.00	Total value --	\$ 990,491.43	\$ 788,617.89

As is seen from the above, of the 75 counties reporting their mineral production, there were but 40 that reported anything besides clay products. The following 18 counties, Ashe, Brunswick, Camden, Caswell, Currituck, Dare, Graham, Hertford, Hyde, Jones, Northampton, Onslow, Pamlico, Perquimans, Richmond, Stokes, Tyrrell, Watauga did not report any production of any mineral whatever during 1901.

Jackson county leads the list in the value of the mineral production (except clay products), their value being \$163,641.93, while Guilford county produced the greatest amount of clay products, which were valued at \$110,974.

The county whose total mineral production was greatest in 1901 was Jackson, the value of the production being \$163,659.93.

BULLETINS OF THE NORTH CAROLINA GEOLOGICAL SURVEY.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Postage 10 cents.*
2. Building Stone in North Carolina, by Joseph A. Holmes and J. Volney Lewis. *In preparation.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and Geo. B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Postage 10 cents.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 2 cents.*
8. Water Powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Postage 4 cents.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Postage 10 cents.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Postage 4 cents.*
12. Drinking Water Supplies in North Carolina, by Joseph A. Holmes. *In preparation.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Reis, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
14. Mica Deposits and Mica Mining in North Carolina, by Joseph A. Holmes. *In preparation.*
15. Mineral Waters of North Carolina, by F. P. Venable. *In press.*
16. A List of Elevations in North Carolina, by J. A. Holmes and E. W. Myers. *In preparation.*
17. Historical Sketch of North Carolina Scientific and Economic Surveys; and Bibliography of North Carolina Geology, Mineralogy and Natural History, by J. A. Holmes and L. C. Glenn. *In preparation.*
18. Road Materials and Construction, by Joseph A. Holmes and William Cain. *In preparation.*
19. Corundum and the Peridotites in Western North Carolina, by J. H. Pratt and J. V. Lewis. *In preparation.*
20. The Loblolly Pine in Eastern North Carolina, by W. W. Ashe. *In preparation.*

ECONOMIC PAPERS, No. 1, on the Maple Sugar Industry in Western North Carolina, by W. W. Ashe; No. 2, on recent road legislation in North Carolina, by J. A. Holmes; No. 3, on Talc and Pyrophyllite Deposits in North Carolina, by J. H. Pratt; No. 4, on the Mining Industry in North Carolina for 1900, by J. H. Pratt; No. 5, Road Laws of North Carolina (out of print), by J. A. Holmes; No. 6, on the Mining Industry in North Carolina for 1901, by J. H. Pratt; are also distributed free, on the payment of postage, 2 cents in each case, except No. 6, which requires 4 cents.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of postage needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

THE NORTH CAROLINA GEOLOGICAL SURVEY

Economic Paper, No. 7

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1902

BY

JOSEPH HYDE PRATT

MINERALOGIST



RALEIGH

E. M. UZZELL & Co., PUBLIC PRINTERS AND BINDERS

1904

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LETTER OF TRANSMITTAL.

RALEIGH, N. C., May 1, 1902.

To His Excellency, HON. C. B. AYCOCK,
Governor of North Carolina.

SIR:—As the seventh of the series of Economic Papers, I have the honor to submit for publication a report on the *Mining Industry* in North Carolina for 1902. This publication takes up the statistics of the production of the various minerals that were mined in the State during 1902, and is, in some respects, an appendix to the report on the Mining Industry of North Carolina for 1901, which takes up in detail descriptions of the occurrences of the deposits of the economic minerals of the State.

Yours obediently,

J. A. HOLMES,
State Geologist.

MINING INDUSTRY IN NORTH CAROLINA DURING 1902.

INTRODUCTION.

The present report of the mining industry in North Carolina during 1902 is simply an appendix to the report for 1901, and is composed principally of tables supplementary to the previous report, with simply sufficient text to make these tables intelligible. A more elaborate report will be published for the mining industry during 1903, which will include descriptions of new mineral localities. From the amount of development work that was being done in the different mineral localities in North Carolina at the close of 1901, it was confidently expected that the mineral production in North Carolina during 1902 would be considerably larger than that of the year before. That these expectations have been realized is shown by the statistics of the production of the various minerals, the aggregate value of which in 1902 was \$2,003,077, which is an increase of \$223,968 over the value of the total production in 1901, which was \$1,779,109.

The more notable changes have been the large increase in the production of gold, copper, iron and barytes, while there was no production of corundum and a large decrease in that of garnet, two minerals which were among the more prominent of those mined in North Carolina. There was also a very material growth in the building stone industry, principally in the production of granite.

A great deal of development work was carried on throughout the State, and a number of new localities opened up, so that at the close of 1902 the condition of the mining industry in North Carolina is very promising for a still further increase in the production of minerals in the State during 1903.

GOLD AND SILVER.

The total production of gold and silver in the State in 1902 was valued at \$123,862 (coining value), which is an increase of \$29,429 over that of 1901, which was valued at \$94,433.

Of this production, the value of the gold was \$93,650, this being

an increase of \$33,240 over that of 1901, which was valued at \$60,410.

The production of silver in 1902 was \$30,212 (coining value), which is a decrease of \$3,811 over the production of 1901, this latter amounting to \$34,023. Nearly all of the silver was obtained from copper ores that were produced in the State, and this indicates the fineness of the gold.

This production of gold and silver was divided among thirty-three counties. The county producing the largest amount of gold was Montgomery, with a production valued at \$38,498; while the smallest production was from Caldwell and Cumberland counties, each of which is credited with a production valued at \$18.60. Mecklenburg was the second largest producer of gold, with a production valued at \$20,439, and Rowan third, with a production valued at \$10,131. The production of silver was confined almost entirely to Rowan and Person counties, from which were also obtained nearly all of the copper produced in 1902. Rowan leads, with a production valued at \$16,401, and Person is second, with a production valued at \$10,520, their combined value being \$26,921, or only \$3,291 less than the value of the total production. In the table below is given the production of gold and silver in North Carolina during 1902 (in coining value) by counties:

PRODUCTION OF GOLD AND SILVER IN 1902, BY COUNTIES.*

COUNTY.	GOLD.†	SILVER.†	TOTAL.
Burke -----	\$ 3,536.19	\$ 42.07	\$ 3,578.26
Cabarrus -----	1,049.30	87.20	1,136.50
Caldwell -----	18.60	.11	18.71
Catawba -----	1,544.93	15.97	1,560.90
Chatham -----	127.76	2.55	130.31
Cherokee -----	1,221.86	5.67	1,227.53
Clay -----	198.14	1.41	199.55
Cumberland -----	18.60	.11	18.71
Davidson -----	603.24	367.77	971.01
Franklin -----	625.77	6.24	632.01
Gaston -----	205.30	3.19	208.49
Granville -----	253.23	937.75	1,190.98
Guilford -----	929.45	36.57	966.02
Halifax -----	1,350.56	5.14	1,355.70
Henderson -----	490.19	10.63	500.82
Iredell -----	231.61	2.89	234.50
Lincoln -----	144.74	.54	145.28
Macon -----	93.02	.58	93.60
McDowell -----	2,048.85	36.63	2,085.48
Mecklenburg -----	20,439.58	860.41	21,299.99
Montgomery -----	38,498.15	675.00	39,173.15
Moore -----	542.75	19.55	562.30
Nash -----	292.24	6.79	299.03
Orange -----	504.70	18.71	523.41
Person -----	1,241.47	10,520.50	11,761.97
Polk -----	1,325.70	12.98	1,338.68
Randolph -----	1,064.48	11.30	1,075.78
Rowan -----	10,131.17	16,401.86	26,533.03
Rutherford -----	2,241.15	27.96	2,269.11
Stanly -----	862.03	5.00	867.03
Union -----	719.90	34.45	754.35
Warren -----	118.86	1.73	120.59
Unknown -----	976.78	53.21	1,029.99
Total -----	\$ 93,650.30	\$ 30,212.47	\$ 123,862.77

* The gold and silver statistics have been obtained through the courtesy of Mr. Geo. B. Hanna, of the United States Government Assay Office, Charlotte, N. C.

† Coining value.

Of this production of gold and silver, \$16,740 was obtained from placer mines, of which \$16,588 was gold and \$152 silver. The value obtained from milling was \$56,221, of which \$54,987 was due to gold and \$1,234 to silver. There was obtained from shipping ores, which were largely copper ores, \$21,063 in gold and \$28,807 in silver. Dredge mining, which had been carried on to a very limited extent in 1901, was practically abandoned in 1902, and only \$21.59 was reported as the value of gold obtained by this method of mining.

In the table that follows there are given the values of the production of gold and silver for the years 1882 to 1902, inclusive:

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA
FROM 1882 TO 1902.*

YEAR.	GOLD.	SILVER.	TOTAL.
1882 -----	\$ 190,000	\$ 25,000	\$ 215,000
1883 -----	167,000	3,000	170,000
1884 -----	157,000	3,500	160,500
1885 -----	152,000	3,000	155,000
1886 -----	175,000	3,000	178,000
1887 -----	225,000	5,000	230,000
1888 -----	136,000	3,500	139,500
1889 -----	145,000	3,878	148,878
1890 -----	118,500	7,757	126,257
1891 -----	95,000	6,465	101,465
1892 -----	78,560	12,671	91,231
1893 -----	53,600	17,325	70,925
1894 -----	46,594	455	47,049
1895 -----	54,200	520	54,720
1896 -----	44,300	646	44,946
1897 -----	34,600	388	34,988
1898 -----	84,000	905	84,905
1899 -----	34,500	388	34,888
1900 -----	44,653	15,986	60,639
1901 -----	60,410	34,023	94,433
1902 -----	93,650	30,212	123,862

* Coining value.

The largest producer of gold during 1902 was the Iola mine, at Candor, Montgomery county. Other mines which were among the more prominent producers in 1902 were the Phoenix mine, in Cabarrus county; the Shuford and England mines, in Catawba county; the Emmons mine, in Davidson county, which is shipping principally copper ore; the Capps, Wilhelmina and Surface Hill mines, in Mecklenburg county; the Holloway and Person Consolidated copper mines, in Person county; and the McMacken and Gold Hill mines, of Rowan county.

Besides the work done at the mines that were producers of gold and silver in 1902, there was a great deal of development work carried on at mines in Cabarrus, Davidson, Mecklenburg, Montgomery, Rowan, Randolph and Union counties, which will undoubtedly result in an increased production of gold and silver in 1903 over that of 1902.

COPPER.

The production of copper in 1902 was confined to Davidson, Rowan, Granville and Person counties, with the largest amount from the latter county. The quantity of ore produced amounted to

16,741 tons, with an estimated value of \$212,553, this being an increase of 6,343 tons in quantity and of \$135,653 in value over the production of 1901, which was 10,398 tons, valued at \$76,900.

This large increase in the production of copper indicates the interest that is becoming centered on the North Carolina deposits. Most of the ore was concentrated, at least to some extent, before being shipped. As was noted under the subject of silver, there is considerable silver obtained as a by-product from nearly all of the copper ores that are mined.

Although there was a great deal of development work done at the copper deposits in Ashe and Jefferson counties, there was no production of copper at any of these deposits. At the Ore Knob mine, Ashe county, a pyritic smelter was erected and blown in, but was immediately shut down and no work has been done with the property since. On account of the distance of this mine from the railroad, it is doubtful whether it will again be in active operation until it has better transportation facilities.

IRON.

There was a decided increase in the production of iron in 1902 over that of 1901, and it amounted to 34,336 tons valued at \$52,771. This is an increase of 31,758 tons in quantity and of \$47,774 in value over the production of 1901, which was 2,578 tons valued at \$4,997. The greater portion of this production was from Mitchell county, with smaller amounts from Johnston and Madison counties.

The blast furnace at Greensboro, N. C., owned by the Empire Steel and Iron Company, was put in operation December 9, 1902, but was blown out December 24th of the same year, having been in blast only two weeks. It is expected, however, that the furnace will be in blast nearly all of the year 1903. This should cause a considerable demand for the iron ores of Johnston and Chatham counties.

ABRASIVES.

Abrasive materials, which are among the most important of the minerals mined, are obtained to some extent in North Carolina. Those that have been mined during recent years in this State are corundum, garnet and millstones. The demand for abrasive materials is constantly on the increase, although there is a considerable

variation noted from year to year in the production of the various kinds of abrasives.

CORUNDUM.

There was no production of corundum in North Carolina during 1902, although the deposits of this mineral in the State are the most extensive of any known in the United States, with the exception of the emery deposits of Massachusetts. There was some development work carried on by the North Carolina Corundum Company at Buck Creek, Clay county; and a complete mill for cleaning and sizing the corundum was erected. The company expect to be producers and shippers of this mineral in 1903.

GARNET.

The quantity of garnet produced in North Carolina in 1902 amounted to 260 short tons valued at \$10,040 as compared with 775 tons valued at \$43,000 produced in 1901, showing a decrease of 510 tons in quantity and of \$32,960 in value. The production of garnet is obtained entirely from Jackson county.

MILLSTONES.

Millstones or buhrstones have been manufactured in North Carolina to a limited extent for a great many years for local purposes in the mountain sections of the State, but it is only within the past few years that any attempt was made to produce this stone for commercial purposes. This has now been undertaken by Mr. J. T. Wyatt at Faith, Rowan county, in connection with his other stone business. The production of these stones for 1902 was 50 pairs valued at \$1,425, which were sold in North Carolina and Georgia. Where formerly millstones or buhrstones were used in large numbers, principally for grinding wheat, there are now but very few used for this purpose, and it is for grinding the coarser cereals, mineral paint ores, fertilizers, cement rock, barytes and other minerals that is causing an increase in the demand for them. For some of these purposes the stone produced in Rowan county should give good satisfaction.

MICA.

The total production of plate mica in North Carolina during 1902 was 329,466 pounds valued at \$81,653, this being an increase of \$1,804 in value, as compared with the value of the production of 1901, which was \$79,849. The scrap mica produced in 1902 was only 324 tons valued at \$2,219, which is a decrease of 1,451 tons in quantity and of \$11,281 in value as compared with the production of 1901, which amounted to 1,775 tons valued at \$14,200. There has been a constant decrease in the production of scrap mica for the past three or four years, due to the fact that where formerly a large proportion of the scrap mica produced was obtained from old dumps and piles of scrap mica left during the mica mining of twenty years ago, when there was no demand for it; at the present time a large part of the scrap mica produced is that obtained from the present mining. It also to be noticed that there has been a constant increase in the production of sheet or plate mica during this same time, and in the following table there is given the approximate value of the production of this sheet mica by counties for the years 1900, 1901 and 1902.

VALUE OF THE PRODUCTION OF SHEET MICA IN 1900, 1901 AND 1902,
BY COUNTIES.

COUNTY.	1900.	1901.	1902.
Buncombe -----	\$-----	-----	\$ 250
Haywood -----	11,000	11,500	20,000
Jackson -----	7,000	8,740	5,700
McDowell -----	1,000	500	600
Macon -----	5,200	-----	4,000
Mitchell -----	26,722	33,506	28,203
Stokes -----	1,000	-----	1,000
Transylvania -----	500	600	750
Yancey -----	12,788	25,003	21,150
Total value -----	\$ 65,200	\$ 79,849	\$ 81,653

As far as can be judged from the mining that is now being carried on and the amount of development work and prospecting that was done in 1902, the production of sheet mica in 1903 should be considerably in excess of that for 1902. There is a constant demand for North Carolina mica, which is increasing, and many orders received for this mica cannot be filled.

QUARTZ.

Although there have been some inquiries during the past year for quartz deposits suitably located so that they could be utilized in the manufacture of pottery, nothing has been done as yet to open up such deposits for this purpose. The only quartz that was mined in 1902 in North Carolina was in Cherokee county, and the entire production was used for flux in the copper smelter at Ducktown, Tennessee. This production amounted to 4,500 tons valued at \$11,250, this being an increase of 1,500 tons in quantity and of \$3,700 in value as compared with the production of 1901, which was 3,000 tons valued at \$7,500.

GEM MINERALS.

The gem minerals of North Carolina, which are of great variety, are obtained principally from Alexander, Burke, Iredell, Lincoln, McDowell, Macon, Mitchell and Yancey counties. The minerals that have been mined during 1902 and classified as gems were rhodolite, pyrope and almandine garnets, various colored beryls, corundum gems, quartz gems, and a number of other minerals which have been sold as mineral specimens. The total value of all the gems produced during 1902 was \$5,300, this being a decrease of \$18,905 in value as compared with the production of 1901, which was \$24,205. The larger proportion of the gems are obtained from Macon county, while Mitchell county is the second largest producer. The gem that was produced in greatest quantity is the rhodolite.

RARE MINERALS.

There was some demand in 1902 for the minerals zircon, uraninite and samarskite, which resulted in a production valued at \$420. The larger part of this value was for zircon obtained in Henderson county, and which was used in the manufacture of the glower for the Nernst electric lamp. The samarskite and the uranium minerals, uraninite and gummite, were obtained from Mitchell county. There is a growing demand for the zircon, and considerable interest in the uranium minerals has been aroused from the fact that it is this type of mineral that contains radium.

MONAZITE.

The monazite industry, which was revived in 1898, has continued to grow constantly since that time, and in 1902 the production amounted to 802,000 pounds valued at \$64,160. This is an increase of 53,264 pounds in quantity and of \$4,898 in value as compared with the production of 1901, which amounted to 748,736 pounds valued at \$59,262. The demand for North Carolina monazite is constantly increasing, and during 1902 there were a number of new companies who entered the field to produce this mineral, one of which, the German Monazite Company, expects to export its entire production. Thus the production of 1903 will undoubtedly be much larger than that of 1902. The quantity and value of the production of monazite since 1893 is shown in the following table:

PRODUCTION OF MONAZITE IN NORTH CAROLINA FROM 1893 TO 1902.

YEAR.	POUNDS.	VALUE.
1893.....	130,000	\$ 7,600
1894.....	546,855	36,193
1895.....	1,573,000	137,150
1896.....	30,000	1,500
1897.....	44,000	1,980
1898.....	250,776	13,542
1899.....	350,000	20,000
1900.....	908,000	48,805
1901.....	748,736	59,262
1902.....	802,000	64,160

As is seen from the above table, the quantity of monazite produced in 1900 of 908,000 pounds is greater than for either 1901 or 1902, although the value is less than for either of these years. This is due to the fact that the monazite sand was cleaner and contained a higher percentage of thorium in 1901 and 1902 than in 1900. One concentrating plant has been erected which will clean the monazite sand to such an extent that the refined product contains 95 per cent. or over of monazite. This production of monazite was obtained from Burke, Cleveland, Lincoln, McDowell and Rutherford counties.

BARYTES.

There was a very noticeable increase in the production of barytes in 1902, which was due to the more extensive mining of the deposits

of Madison county. The total production of this mineral for 1902 was 14,679 tons valued at \$44,130, which is an increase of 7,289 tons in quantity and of \$21,515 in value as compared with the production of 7,390 tons valued at \$22,615 in 1901. Although this production of 1902 was nearly double that of the previous year, it is expected that there will be a still further increase in the production of 1903, as there is a growing demand for this mineral, due to new uses that have been found for it. The larger part of the 1902 production was from Madison county; the only other county reporting a production was Gaston.

TALC AND PYROPHYLLITE.

There was a falling off in the quantity of talc produced in North Carolina during 1902, although there was an increase in the value, this being due to a smaller quantity of the pyrophyllite variety that was mined and to an increase in the quantity of the higher grades of talc which were capable of being cut into tailors' pencils, etc. The production of these minerals in 1902 amounted to 5,239 short tons valued at \$88,962, which shows a decrease of 580 tons in quantity but an increase of \$10,988 in value as compared with the production for 1901 of 5,819 tons valued at \$77,974. The larger amount of this production was from Swain county, with smaller amounts from Cherokee and Moore counties. The condition in which this talc was marketed is shown in the following table:

TALC PRODUCTS OF NORTH CAROLINA IN 1901 AND 1902.

	1901.		1902.	
	TONS.	VALUE.	TONS.	VALUE.
Ground talc, for powders, etc.-----	2, 864	\$29, 505	3, 381	\$ 31, 628
Talc cut into pencils, gas tips, etc.-----	375	26, 000	371	42, 017
Talc sold crude-----	2, 580	22, 319	1, 487	15, 317
Soapstone cut into slabs for chimneys, etc.-----		150		
Total-----	5, 819	\$77, 974	5, 239	\$ 88, 962

GRAPHITE.

The principal graphite deposits in North Carolina are in McDowell and Wake counties, and these were the only ones that made any production in 1902, this amounting to 830 tons valued at \$4,300.

This is an increase of 735 tons in quantity and of \$3,741 in value as compared with the production of 1901, which was 95 tons valued at \$559. A deposit of graphite is being developed in Yancey county about 7 miles east of Burnsville. A graphite mill to treat this ore is to be erected about 17 miles southeast of Burnsville on the headwaters of South Toe river. It is uncertain just when the company will begin to ship this graphite.

COAL.

The production of coal during 1902 in North Carolina was from the Cumnock mines in Chatham county and amounted to 23,000 tons valued at \$24,500 as compared with 3,723 tons valued at \$5,585 in 1901. This shows an increase in the production of 19,277 tons in quantity and of \$23,913 in value.

The quality of the coal is good, and there is a local State market for all this coal that can be produced.

BUILDING STONES.

There was a considerable increase in the total production of building stones in North Carolina in 1902, and the value of this production was \$366,727, this being an increase of \$81,983 as compared with the value of the total production of 1901, which was \$284,744. This increase was due principally to the production of granite. There should be a still greater growth in the building stone industry in North Carolina, for the State is exceptionally well provided with stone suitable for these purposes, which are found abundantly in the middle and western counties, including sandstone, granite, marble, limestone and slate.

SANDSTONE.

The sandstone industry has always been small in North Carolina, although there is sandstone of good quality in Anson, Moore, Chatham, Durham and Wake counties which is extensive and well adapted for building purposes. If sufficient capital would take hold of these quarries and develop them extensively and introduce the stone to the general market, there would undoubtedly arise a considerable demand for it. The production of sandstone in 1902 was principally from Moore county, with a very small amount from Anson. The total

value of this production was \$4,825, all but \$75 of which was used for building purposes. This is a decrease of \$6,857 as compared with the production of 1901, which was valued at \$11,682.

GRANITE.

The granite industry is the most extensive of any of the building stone industries in the State, and the total value of all the granite produced in 1902 was \$338,749, which is an increase of \$73,843 as compared with the production for 1901 of \$264,906. The number of operators engaged in quarrying granite was 27, who worked at 30 different localities in the following 12 counties: Buncombe, Cabarrus, Catawba, Forsyth, Gaston, Henderson, McDowell, Orange, Rowan, Surry, Vance and Wake. The county of Rowan had the largest number of operators, which was 12, and also made the largest production, which was valued at \$122,319. Gaston county, with 5 operators, had the lowest production which was valued at \$2,666. Surry county, with but one operator, was second in the value of its production.

Nearly one-half of the granite produced in the State during 1902 was used for building and monumental purposes, which is an increase of \$59,065 as compared with the value of the granite used for the same purposes in 1901. In the table below is given the different purposes for which the granite quarried in 1901 and 1902 was used:

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1901 AND 1902.

USES.	1901.	1902.
Building and monumental purposes-----	\$ 108, 574	\$ 167, 639
Paving blocks-----	10, 662	6, 986
Curbing and flagging-----	56, 245	82, 615
Crushed stone for road-making, railroad ballast, etc.---	89, 425	77, 759
Other purposes-----		3, 750
Total value-----	\$ 264, 906	\$ 338, 749

MARBLE AND LIMESTONE.

There was no production of marble in North Carolina during 1902, although there was some development work carried on by a number of companies organized to quarry this stone in Swain and Cherokee

counties. The main difficulty regarding the production of marble in this State has been the distance from the market.

The production of limestone during 1902 was valued at \$23,153, which is an increase of \$14,796 as compared with the production for 1901, which was valued at \$8,356. None of the production was used for building purposes, by far the larger portion being used for making roads. This production of limestone was obtained from Henderson, New Hanover and Pender counties. All of the production of New Hanover county was used for road purposes, and that of the others for burning into lime.

In the following table is shown the uses for which the production of 1901 and 1902 was used:

USES OF LIMESTONE MINED IN 1901 AND 1902.

USES.	1901.	1902.
Building purposes -----	\$ 237. 50	\$ -----
Made into lime -----	3, 688. 00	2, 090. 00
Road materials, curbing, etc. -----	4, 668. 00	21, 063. 00
Total value -----	\$ 8, 356. 50	\$ 23, 153. 00

CLAY.

The total value of all clays and clay products, including kaolin or china clay, pottery clay, fire- and pipe-clay and brick-clay, produced in North Carolina during 1902 was \$908,105. This is an increase of \$316 as compared with the production of 1901, which was valued at \$907,789, and is due to the decrease in the production of kaolin. The value of the clay products in North Carolina, with the exception of kaolin, in 1902 was \$800,000, an increase of \$11,383 over the production of 1901, which was valued at \$788,617. There should be a large increase in the production of clay products in North Carolina, as there are good deposits of clay scattered throughout the State suitable for making a very good brick that will stand transportation, and for the manufacture of earthenware, sewer pipe, etc.

KAOLIN OR CHINA CLAY.

The kaolin produced in North Carolina during 1902 was almost entirely from Jackson county, with small amounts from Swain and

Buncombe, and it amounted to 13,322 tons valued at \$108,105. This is a decrease of 3,253 tons in quantity and of \$11,066 in value as compared with the production for 1901 of 15,575 tons valued at \$119,171.

POTTERY CLAY.

There was a considerable falling off in the production of pottery in North Carolina during 1902, and the total value of this production was only \$14,512, which is a decrease of \$7,983 as compared with the production of 1901, which was valued at \$22,495. There were 26 pottery manufacturers who aided in this production, who were located in 8 counties. There was no decorative ware reported as having been made in 1902, and the production was mostly of stoneware, which was valued at \$13,854, the balance of \$658 being for earthenware. With improved methods, utilizing more care in the manufacture, and by using better material for glazing the ware, the North Carolina potter would be able to put a far better grade of pottery on the market, with practically no more expense, which would sell at a considerably increased price.

The value of the various grades of pottery produced in the different counties during 1901 and 1902 is given in the table below:

VALUE OF THE POTTERY PRODUCTS OF NORTH CAROLINA,
BY COUNTIES, IN 1901 AND 1902.

COUNTY.	1901.				1902.		
	Earthen-ware.	Stone-ware.	Decorative Ware, Etc.	Total.	Earthen-ware.	Stone-ware.	Total.
Buncombe	\$ 280	\$ 3,100	\$-----	\$ 3,320	\$150	\$ 1,850	\$ 2,010
Catawba	-----	2,540	-----	2,540	55	4,410	4,465
Chatham	-----	2,700	-----	2,700	-----	2,000	2,000
Cumberland	60	-----	-----	60	-----	-----	-----
Johnston	525	1,700	-----	2,225	40	525	565
Lincoln	2,500	2,000	25	4,525	25	2,900	2,925
Randolph	860	3,173	200	4,233	28	769	797
Union	325	1,040	27	1,392	300	300	600
Warren	-----	-----	300	300	-----	-----	-----
Wilkes	-----	1,200	-----	1,200	50	1,100	1,150
Total	\$ 4,490	\$17,453	\$ 542	22,495	658	13,854	14,512

As is seen from the above table, Cumberland and Warren counties, which produced pottery in 1901, reported no production in 1902. The four counties reporting a production of decorative ware in 1901 manufactured none of this variety of pottery during 1902.

FIRE-CLAY AND PIPE-CLAY.

The total value of all fire-clay and pipe-clay products reported in 1902 was \$74,036. This includes fire-brick, fire-clay, sewer pipe, tile, etc. This is an increase of \$16,576 in value as compared with the value of the production of 1901, which was \$56,395.

Of the above value, \$1,203 was the value of the fire-brick produced, this being an increase of \$653 over the value of the production in 1901, which was \$550. There was also a small amount of crude fire clay sold in 1902, which was valued at \$215.

The value of the production of sewer pipes, tiles, etc., produced in 1902 was \$72,618 as compared with \$55,745 in 1901. This is an increase of \$16,873, but does not begin to represent the increase that there should be in this industry.

BRICK-CLAY.

In the greater number of counties in North Carolina there are clay deposits suitable for the manufacture of brick, and in 1902 brick were manufactured in sixty-seven counties. The total number of all kinds of brick, except fire-brick, made during 1902 was 133,551,700 valued at \$711,452, which is an average value of \$5.33 per thousand. This is a decrease of 2,164,870 brick, but an increase of \$1,722 in value as compared with the production of 1901, which was 135,716,570 brick valued at \$709,730. This indicates a better quality of brick manufactured in 1902 than in 1901, and the average price received of \$5.33 per thousand is an increase of 10 cents as compared with the average price of \$5.23 per thousand received in 1901. The number of manufacturers engaged in making brick during 1902 was 195, which is 36 less than the number engaged in this business in 1901. The lowest value per thousand reported as having been received for brick was \$3.75 and the highest \$15, this latter value being for a vitrified brick. The highest price reported as having been received for common brick was \$8 per thousand, the

same price as reported in 1901. In the following table is given the total number and value of the different varieties of brick produced in 1902, by counties:

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA
DURING 1902.

COUNTY.	COMMON BRICK.	VALUE.	PRESSED BRICK.	VALUE.	VITRIFIED BRICK.	VALUE.
Alamance -----	5,220,000	\$ 24,075		\$		\$
Anson -----	600,000	3,500				
Beaufort -----	1,440,000	9,000				
Bertie -----	3,616,000	18,635	500,000	4,000		
Bladen -----	400,000	2,000				
Buncombe -----	4,750,000	23,978				
Burke -----	1,700,000	6,800				
Cabarrus -----	85,000	425				
Caldwell -----	1,260,000	5,720				
Carteret -----	990,000	500				
Catawba -----	477,000	2,072				
Chatham -----	100,000	500				
Chowan -----	1,000,000	7,000				
Cleveland -----	1,258,000	6,148				
Columbus -----	1,200,000	6,000				
Craven -----	4,500,000	22,500				
Cumberland -----	3,000,000	15,000				
Davidson -----	2,320,000	13,000				
Duplin -----	263,700	1,458				
Durham -----	5,050,000	25,825				
Edgecombe -----	4,050,000	23,500				
Forsyth -----	3,442,000	15,423				
Franklin -----	200,000	1,400				
Gaston -----	1,725,000	7,845				
Gates -----	105,000	430				
Granville -----	800,000	6,000				
Greene -----	910,000	5,478				
Guilford -----	8,802,000	44,160	240,000	1,900		
Halifax -----	4,050,000	23,500	175,000	1,575		
Harnett -----	2,400,000	9,900				
Haywood -----	400,000	2,200				
Henderson -----	1,000,000	6,000	30,000	450	600,000	6,000
Hertford -----	140,000	880	140,000	880		
Iredell -----	1,500,000	8,050				
Johnson -----	570,000	3,600				
Lenoir -----	3,000,000	18,500				
Lincoln -----	300,000	1,500				
McDowell -----	900,000	5,300				
Martin -----	19,000	105				
Mecklenburg -----	2,765,000	14,418				
Montgomery -----	300,000	1,500	80,000	650		
Moore -----	1,650,000	7,200				
Nash -----	2,000,000	11,000				
New Hanover -----	1,000,000	5,500				
Orange -----	370,000	1,630				
Pasquotank -----	1,650,000	9,575				
Person -----	6,000,000	36,000				
Pitt -----	1,728,000	11,122				
Randolph -----	1,590,000	7,550				

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA
DURING 1902—CONTINUED.

COUNTY.	COMMON BRICK.	VALUE.	PRESSED BRICK.	VALUE.	VITRIFIED BRICK.	VALUE.
Roberson -----	625,000	\$ 3,780	-----	\$-----	-----	\$-----
Rockingham -----	4,447,000	22,267	-----	-----	-----	-----
Rowan -----	1,800,000	10,500	-----	-----	-----	-----
Rutherford -----	200,000	850	-----	-----	-----	-----
Sampson -----	100,000	500	-----	-----	-----	-----
Scotland -----	500,000	2,500	-----	-----	-----	-----
Stanly -----	500,000	2,570	-----	-----	-----	-----
Surry -----	1,115,000	5,955	-----	-----	-----	-----
Transylvania -----	600,000	3,000	-----	-----	-----	-----
Union -----	900,000	4,685	-----	-----	-----	-----
Vance -----	100,000	700	-----	-----	-----	-----
Wake -----	5,215,000	26,573	50,000	450	-----	-----
Warren -----	100,000	500	-----	-----	-----	-----
Washington -----	160,000	1,100	-----	-----	-----	-----
Wayne -----	13,850,000	70,350	-----	-----	-----	-----
Wilkes -----	1,325,000	6,380	115,000	690	-----	-----
Wilson -----	8,333,000	48,950	-----	-----	-----	-----
Yadkin -----	53,000	265	33,000	30	-----	-----
Total -----	131,618,700	\$ 694,827	1,333,000	\$ 10,625	600,000	\$ 6,000

As is seen from the above table, of the ninety-seven counties in North Carolina all but thirty reported a production of some variety of brick. In Wayne county were made the greatest number of brick, which amounted to 13,850,000 valued at \$70,350. Guilford county is second with a production of 9,042,000 valued at \$46,060. The county producing the smallest number of brick was Martin, which reported a production of 19,000 valued at \$105.

There is given in the table below the value of all the clay products produced in North Carolina in 1901 and 1902:

VALUE OF CLAY PRODUCTIONS OF NORTH CAROLINA IN 1901 AND 1902.

	1901.		1902.	
	QUANTITY.	VALUE.	QUANTITY.	VALUE.
Common brick -----	134, 441, 570	\$ 697, 860. 84	131, 611, 700	\$ 694, 827. 00
Pressed brick -----	1, 095, 000	10, 220. 00	1, 233, 000	10, 625. 00
Vitrified brick -----	180, 000	1, 650. 00	600, 000	6, 000. 00
Fire-brick -----	550	550. 00		1, 203. 00
Earthenware -----		4, 490. 00		658. 00
Stoneware -----		17, 453. 00		13, 854. 00
Decorated ware -----		552. 00		
Sewer pipe, tile, etc.-----		55, 745. 05		72, 618. 00
	Tons		Tons	
Kaolin -----	15, 575	119, 171. 83	13, 322	108, 105. 00
Fire-clay -----		100. 00		215. 00
Total value -----		\$ 907, 789. 72		\$ 908, 105. 00

The above statistics regarding the clay production of the State do not perhaps represent the entire output of clay products, as in a number of the mountain counties a few thousand brick are occasionally made for local purposes, of which it is difficult or impossible to obtain any record.

SUMMARY.

The increase of \$223,968 in the total value of the mineral production of the State for 1902 over that of 1901 indicates the growing interest that is taken in the mineral deposits of North Carolina. The above figures are especially significant when it is considered that this increase in the value of the mineral production is exclusive of all clay products. Not only has more value been taken out of the mineral deposits of the State during 1902 than for many-years past, but that year has also seen more capital invested in thorough and competent development work than ever before, which will mean a still greater value in the mineral production in the next few years. There are a number of mining propositions throughout the State that are worthy of investigation and the investment of capital. Among these are the clay deposits, which are suitable for the manufacture of pressed brick, fancy brick and pottery. When it is considered that most of these

products are now being brought into the State, while there are clay deposits in the State that are suitable for making just as good or better manufactured products than those that are imported, it should be an incentive for capital to invest in this industry. The stone industry is another inviting field for capital, and with the consolidation of a number of the better quarries a large and very prosperous business should be the result. Other propositions are the low-grade gold ores, corundum mines and barytes deposits.

In the following table there is given the total mineral production of the State for the years 1900, 1901 and 1902:

THE MINERAL PRODUCTION IN NORTH CAROLINA FOR THE YEARS
1900, 1901 AND 1902.

MINERAL.	VALUE.		
	1900.	1901.	1902.
Gold-----	\$ 46,653.00	\$ 60,410.71	\$ 93,650.00
Silver-----	15,986.00	34,023.64	30,212.00
Copper-----	41,600.00	76,900.00	212,553.00
Iron-----	42,000.00	4,997.00	52,771.00
Pyrite-----	14,625.00	32,000.00	-----
Corundum-----	36,840.00	48,840.00	-----
Garnet-----	18,000.00	43,000.00	10,040.00
Mica { Sheet-----	65,200.00	79,849.00	81,653.00
{ Scrap-----	36,262.00	14,200.00	2,919.00
Quartz-----	-----	7,500.00	11,250.00
Barytes-----	-----	22,615.00	44,130.00
Monazite-----	48,805.00	59,262.00	64,160.00
Talc-----	42,000.00	77,974.00	88,962.00
Gem minerals, etc.-----	12,020.00	24,245.00	5,300.00
Rare minerals-----	-----	-----	420.00
Graphite-----	-----	559.25	4,300.00
Coal-----	22,500.00	5,585.00	24,500.00
Building stones-----	285,172.00	284,744.00	366,727.00
Millstones-----	-----	-----	1,425.00
Kaolin-----	62,440.00	119,171.83	108,105.00
Clay products-----	815,975.00	788,617.89	800,000.00
Total value-----	\$1,604,078.00	\$1,779,109.32	\$ 2,003,077.00

There were seventy-nine counties out of the ninety-seven in the State from which the mineral production of 1902 was obtained, and in the following table the value of this production for each county is given. The value of the clay products, with the exception of kaolin, which is included with the other minerals, is given separately from the rest of the mineral production, the total value of which is given.

VALUE OF MINERAL PRODUCTION, BY COUNTIES, IN NORTH
CAROLINA IN 1901 AND 1902.

COUNTY.	1901.			1902.		
	Mineral Production, including Kaolin.	Clay Products except Kaolin.	Total.	Mineral Production, including Kaolin.	Clay Products except Kaolin.	Total.
Alamance	\$ 400.00	\$ 21,965.00	\$ 22,365.00	\$ 200	\$ 24,075	\$ 24,075
Alexander	175.00		175.00			200
Alleghany	720.00		720.00			
Anson	1,800.00	3,000.00	4,800.00	4,250		4,250
Ashe						
Beaufort		10,480.00	10,480.00		9,500	9,500
Bertie		3,162.00	3,162.00		22,653	22,653
Bladen		2,250.00	2,250.00		2,018	2,018
Brunswick						
Buncombe	15,090.01	15,469.85	30,559.86	18,375	27,463	45,838
Burke	24,282.00	4,800.00	29,082.00	10,238	6,800	17,038
Cabarrus	22,426.71	15,250.00	37,676.71	10,650	425	11,076
Caldwell	70.00	6,410.00	6,480.00	19	5,720	5,739
Camden						
Carteret		2,425.00	2,425.00		500	500
Caswell						
Catawba		6,710.00	6,710.00	8,336	6,562	14,898
Chatham	5,585.00	2,700.00	8,285.00	24,630	2,500	27,130
Cherokee	27,500.00		27,500.00	21,952		21,952
Chowan	7,000 0.00		7,000.00	7,000		7,000
Clay	9,000 0.00		9,000.00	200		200
Cleveland	17,532.00	8,100.00	25,632.00	16,000	6,148	22,148
Columbus		12,450.00	12,450.00		6,000	6,000
Craven		16,750.00	16,750.00		22,500	22,500
Cumberland		7,560.00	7,560.00	19	15,000	15,019
Currituck						
Dare						
Davidson	2,500.00	7,400.00	7,400.00	27,971	13,000	40,971
Davie	15,000 0.00		15,000.00			
Duplin		1,306.00	1,306.00		1,458	1,458
Durham		40,275.00	40,275.00		25,825	25,825
Edgecombe		20,270.00	20,270.00		23,500	23,500
Forsyth	3,906.00	48,206.00	52,112.00	3,057	15,623	18,680
Franklin		3,500.00	3,500.00	632	1,400	2,032
Gaston	42,279.50	15,630.00	57,909.50	8,874	7,845	16,719
Gates		425.00	425.00		430	430
Graham						
Granville		6,250.00	6,250.00	3,996	6,000	9,996
Greene		6,653.48	6,653.48		5,478	5,478
Guilford		110,974.00	110,974.00	966	117,560	118,526
Halifax		13,460.00	13,460.00	1,356	25,075	26,431
Harnett		5,600.00	5,600.00		9,900	9,900
Haywood	13,124.00	2,500.00	15,624.00	20,850	2,200	23,050
Henderson	13,169.43	14,325.00	27,494.43	16,201	12,450	28,651
Hertford					1,760	1,760
Hyde						
Iredell	70.00	8,885.00	8,955.00	434	8,050	8,484
Jackson	163,641.93	18.00	163,659.93	119,905		119,905
Johnston		10,575.00	10,575.00	475	4,165	4,640
Jones						
Lenoir		13,000.00	13,000.00		18,500	18,500
Lincoln	100.00	6,275.00	6,375.00	9,845	4,425	14,270
McDowell	37,074.00	6,300.00	43,374.00	42,715	5,300	48,015
Macon	58,180.00		58,180.00	6,344		6,344
Madison	14,795.00		14,795.00	42,630		42,630
Martin		325.00	325.00		105	105
Mecklenburg	32,149.00	41,062.00	73,211.00	21,300	14,418	35,718
Mitchell	42,835.06		42,835.06	79,319		79,319
Montgomery	2,000.00	200.00	2,200.00	39,173	2,150	41,323
Moore	18,796.00	10,220.00	29,016.00	13,987	7,200	21,187
Nash	100.00	24,100.00	24,200.00	299	11,000	11,299
New Hanover	4,668.00	3,000.00	7,668.00	21,063	5,500	26,563
Northampton						
Onslow						
Orange		4,345.00	4,345.00	5,462	1,648	7,110
Pamlico						
Pasquotank		10,450.00	10,450.00		9,575	9,575
Pender	600.00		600.00	470		470

VALUE OF MINERAL PRODUCTION, BY COUNTIES, IN NORTH
CAROLINA IN 1901 AND 1902—CONTINUED.

COUNTY.	1901.			1902.		
	Mineral Production, including Kaolin.	Clay Products except Kaolin.	Total.	Mineral Production, including Kaolin.	Clay Products except Kaolin.	Total.
Perquimans	\$	\$		\$	\$	\$
Person	47,000.00	3,000.00	50,000.00	157,010	36,000	193,010
Pitt		1,794.73	1,794.73		11,122	11,122
Polk	300.00		300.00	1,339		1,339
Randolph	20,165.00	7,377.02	27,542.02	1,076	8,547	9,623
Richmond						
Robeson		8,689.00	8,689.00		3,780	3,780
Rockingham		3,850.00	3,850.00		22,237	22,237
Rowan	126,438.15	18,400.00	144,838.15	187,777	10,500	198,277
Rutherford	8,989.64	7,783.00	16,772.64	18,269	850	19,119
Sampson		9,100.00	9,100.00		500	500
Scotland		5,000.00	5,000.00		2,500	2,500
Stanly	2,660.16	2,000.00	4,660.16	867	2,570	3,437
Stokes				1,000		1,000
Surry	88,654.00		88,654.00	116,965		116,965
Swain	40,115.00		40,115.00	74,187		70,187
Transylvania	1,440.00	875.00	2,315.00	780	3,100	3,880
Tyrrell						
Union		12,807.00	12,807.00	754	5,285	6,039
Vance	18,700.00	700.00	19,400.00	17,554	700	18,254
Wake	21,034.25	22,357.81	43,391.56	9,200	27,023	36,223
Warren		1,050.00	1,050.00	121	500	621
Washington		1,800.00	1,800.00		1,100	1,100
Watauga						
Wayne		39,450.00	39,450.00		70,350	70,350
Wilkes		5,465.00	5,465.00		8,220	8,220
Wilson		17,700.00	17,700.00		48,950	48,950
Yadkin		315.00	315.00		295	295
Yancey	33,995.00		33,995.00	22,159		22,159
Unknown				1,030		1,030
Total value	\$ 990,491.43	\$ 788,617.89	\$ 1,779,109.32	\$ 1,203,077	\$ 800,000	\$ 2,003,077

Of the seventy-nine counties reporting a mineral production for 1902 there were only fifty-one counties that reported anything besides clay products. There were sixty-six counties reporting a production of clay, of which twenty-eight counties did not report any other mineral production. There were nine counties which reported a mineral production, but none of clay products. The number of counties producing both clay and other mineral products was forty-two. There were eighteen counties that did not report the production of any mineral whatever during 1902. The county the value of whose mineral production (except clay products) was greatest was Rowan, the value being \$187,777. The county producing the greatest value of clay products was Guilford, the value of which was \$117,560. The county whose total mineral production was greatest in 1902 was Rowan, the value of the production being \$198,277. Person county is a close second, with a production valued at \$193,010. The lowest value reported by any county was \$105, which was the value of the mineral production of Martin county.

BULLETINS OF THE NORTH CAROLINA GEOLOGICAL SURVEY.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Postage 10 cents.*
2. Building Stone in North Carolina, by Joseph A. Holmes, George P. Merrill and T. L. Watson. *In preparation.*
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THE NORTH CAROLINA GEOLOGICAL SURVEY

Economic Paper No. 8

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1903

BY

JOSEPH HYDE PRATT, PH. D.

MINERALOGIST



RALEIGH

E. M. UZZELL & Co., PUBLIC PRINTERS AND BINDERS

1904

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LETTER OF TRANSMITTAL.

RALEIGH, N. C., May 1, 1904.

To His Excellency, HON. C. B. AYCOCK,
Governor of North Carolina.

SIR:—As the eighth of the series of Economic Papers, I have the honor to submit for publication a report on the *Mining Industry* in North Carolina for 1903. This publication takes up the statistics of the production of the various minerals that were mined in the State during 1903, and gives in detail descriptions of the occurrences of those mineral deposits of economic importance that have not been previously discussed.

Yours obediently,

J. A. HOLMES,
State Geologist.

MINING INDUSTRY IN NORTH CAROLINA DURING 1903.

By JOSEPH HYDE PRATT.

INTRODUCTION.

The mineral production of North Carolina during 1903 was somewhat smaller than that of 1902, although there was a decidedly progressive and substantial development of the mineral properties in the State. This is shown more especially in the development of the gold and copper properties, many of which, though not producing any metal in 1903, are in a condition to become producers during 1904. There was a decided increase in the production of iron ores, but a falling off in the production of talc and kaolin; not due, however, to the lack of demand for these latter two minerals, but to the scarcity of the supply.

There has been a continual increase in the quantity and value of the production of clay products for a number of years and during 1903 there was a considerable increase in this production. Thus, at the present time, the total value of the production of clay products and kaolin is practically one-half of the total mineral production of the State.

The deposits that are attracting perhaps more attention than any other are the gold ores of the State; and, while there was some increase in the production of gold in 1903 over that of 1902, it may be confidently expected from the amount of systematic development work that has been carried on during the past year that there will be a much larger increase in the value of the production during 1904. This work has been applied largely to the development and re-opening of old deposits.

Another metal that is attracting considerable attention is tin, and the deposits of cassiterite, the ore of tin, in Gaston County are being prospected and developed very vigorously.

The aggregate value of the mineral production in North Carolina during 1903 was \$1,902,485 as compared with \$2,003,077, the value of the total production in 1902, which is a decrease of \$100,592. As compared with the value of the production of 1901, which was \$1,779,109, this is an increase of \$123,376. The minerals and ores that have been mined and have added to the production of mineral products in North Carolina in 1903 are given below in the order in which they are discussed in the following pages: Gold and Silver, Copper, Iron, Corundum, Garnet, Millstones, Mica, Quartz, Barytes, Monazite, Talc and Pyrophyllite, Precious Stones, Rare Earth Minerals, Graphite, Coal, Stone, Kaolin and Clay Products.

GOLD AND SILVER.

The area in North Carolina in which gold and silver deposits are known to occur embraces from 8,000 to 10,000 square miles of the middle and western counties. In this area there are over 400 localities in the State that have been mined for gold and silver. In 1903 there were 31 counties that added to the production of these metals. In some the gold was obtained as a by-product in placer mining for other minerals, such as monazite, and in other cases was obtained in development work or prospecting and amounted to but a few ounces of these metals. There has been a large amount of systematic development work carried on at many localities throughout the State on properties that have not been producers for many years, and a number of these are now in a condition so that they will be producers of these metals in 1904. Many of the properties that were producers in 1902 largely increased their production in 1903, and have enlarged their mills and reduction plants so as to be able to treat a greater output of ore during the next year. Experimental work has been carried on to some extent to determine the feasibility of treating many of the sulphide ores in the State by the cyanide process, and at the Colossus mine (formerly the Howie mine) in Union County, such ores are being successfully treated.

MINES PRODUCING GOLD AND SILVER IN 1903.

In 1903 there were 37 properties that could be designated as working mines that made a production of gold and silver. These were

located in 17 different counties. In the table below there is given a list of these mines and the counties in which they are located:

MINES IN NORTH CAROLINA PRODUCING GOLD IN 1903.

NAME OF MINE.	COUNTY.	NAME OF MINE.	COUNTY.
Boger -----	Cabarrus.	Alden & Merrill -----	Moore.
Miami (formerly Phoenix) -----	Cabarrus.	Mann-Arrington -----	Nash.
Shuford -----	Catawba.	Holloway* -----	Person.
M. Ramsay -----	Cherokee.	Tingen* -----	Person.
Norlina -----	Davidson.	Yancey* -----	Person.
Blue Wing* -----	Granville.	Lilian -----	Polk.
Portis -----	Franklin.	Cid -----	Randolph.
Deep River -----	Guilford.	Sawyer or Stillwater -----	Randolph.
Fentress -----	Guilford.	Gold Hill* -----	Rowan.
Gardner -----	Guilford.	Whitney (formerly	
Lindsay -----	Guilford.	McMakin) -----	Rowan.
McCullough -----	Guilford.	Union* -----	Rowan.
Capps Hill -----	Mecklenburg.	Barringer -----	Stanly.
Surface Hill -----	Mecklenburg.	Ingram or Crawford -----	Stanly.
Summerville or		Parker -----	Stanly.
Wilhelmina -----	Mecklenburg.	Colossus (formerly	
Vein Mountain -----	Mecklenburg.	Howie) -----	Union.
Iola -----	Montgomery.	Indian Trail (formerly	
Montgomery -----	Montgomery.	Black) -----	Union.
Russell -----	Montgomery.	Moore -----	Union.

Of the above mines, those marked with an asterisk are copper mines, from the ores of which, however, there is obtained more or less silver and gold as by-products. It might be stated here that nearly all of the silver obtained in North Carolina is as a by-product from the copper mines. The gold is very free from silver, as is indicated by the table on page 17, which gives the production of gold and silver by counties for the year 1903.

In Cabarrus County the Miami Mining Company have been carrying on extensive development work at the Phoenix mine up to January, 1904, this property having been opened up by means of five shafts, six drifts and cross-cuts amounting to 3,932 feet. The deepest shaft is the Old Phoenix, which has been sunk to a depth of 604 feet with 547 feet of drifts on the 150-ft. level; 404 feet of drifts on the 250-ft. level; 594 feet of drifts on the 350-ft. level, and 489 feet of drifts on the lowest or 420-ft. level. From the 420-ft. level a winze 15 feet deep has been sunk and on the 350-ft. level there are a few short cross-cuts. The next deepest

shaft on the property is the Furniss, which is 170 feet deep with 140 feet of drifts on the 100-ft. level and 204 feet of drifts on the 170-ft. level, which also has 84 feet of cross-cuts. The total underground workings of the Phoenix mine are as follows:

UNDER-GROUND WORKINGS OF PHOENIX MINE.

NAME OF SHAFT.	NUMBER OF FEET.			TOTAL.
	SHAFTS.	DRIFTS.	CROSS-CUTS.	
Phoenix-----	101	45	6	152
Junction-----	70		63	133
Copper-----	150	234		384
Old Phoenix-----	604	2, 034	27*	2, 665
Furniss-----	170	344	84	598
Total-----	1, 095	2, 657	180	3, 932

*Includes a 15' winze on 420' level.

The working shafts are double compartments, each measuring 4x4 feet. It is estimated that there are about 35,000 tons of ore blocked out in this mine, the vein averaging 16 inches in width. The mine is equipped with a 10-stamp mill, each stamp weighing 1,050 pounds, and Bartlett concentrating tables. The tailings are cyanided.

While this property produced but little gold in 1903, it is expected that during 1904 it will add considerably to North Carolina's production of this metal.

The North Carolina Mining and Milling Company have been developing a property in Cabarrus County about 4 miles southeast of Concord and 2½ miles north of the Phoenix mine. There has been about 130 feet of shafting sunk on the vein during the development work, but not sufficient work has as yet been done to determine the actual value of the property or to warrant the erection of a mill.

In the Lytton Mining District, near Lytton, Tabernacle Township, Randolph County, North Carolina, there are a number of properties that have been opened up during the past year. Some of these are new ones that have never before been developed, while others are old mines that have been re-opened. The Southern Homestake Gold Mining Company is operating a free milling ore that occurs as parallel bands in a schistose rock, and one of these veins has been opened by a

series of open cuts across the vein for a distance of 12,000 feet along the strike. This is a low-grade ore, averaging from \$3 to \$5 per ton, and this company expect to erect a cyanide plant to recover the values. A few prospect shafts or pits have been sunk on the vein for a depth of 25 to 50 feet. On the Senter gold mining property there are two similar veins or bands of gold-bearing schistose rock that have been opened for a distance of about 4,000 feet along the strike by means of open cuts, pits and short drifts. The width of this gold-bearing strata varies from 100 to 300 feet. The deepest work that has been done is the sinking of one shaft to 70 feet. This property would be another of those that could be worked by open cuts for some years. The Empire gold mining property has the same character of ore and has been developed by means of open cuts and pits. Other properties, in this same district, that contain deposits of a similar character and that have been opened up during the past year are those of the Pierce Mountain Gold Mining Company; the Miller Gold Mining Company; the Jones Gold Mining Company, and the Cameron Mountain Gold Mining Company, the latter adjoining the Southern Homestake Mining Company's property. The Cameron Mountain property has been opened to a depth of 125 feet. All these properties contain low-grade ores and, as sampled by various engineers, have given values ranging something as follows: \$2.50, \$3.90, \$4.80 and \$5.10 per ton. In former years these ores have been worked to some extent by means of Chilian mills; but it is the intention of those now owning these properties to treat them by cyaniding.

Another mine in Randolph County that has been re-opened during the past year is the Parrish mine, and the result of the development work carried on has been the opening up of a vein $31\frac{1}{2}$ feet wide, which is composed almost entirely of actinolite. As far as opened, the ore is free milling and gave on assaying values ranging from \$20 to \$30 per ton. The vein has been opened to a depth of about 30 feet.

The Whitney Company of Salisbury, North Carolina, is actively developing the Barringer mine in Stanly County and the McMakin mine in Rowan County. During the year 1903 there was 450 feet of new drifts made at the McMakin mine, Gold Hill, Rowan County, making, up to January, 1904, a total of 7,712 feet of development work that has been done at this mine, divided as follows: Shafts,

1,621 feet; drifts, 3,635 feet; cross-cuts, 2,456 feet. The deepest shaft on this property is now nearly 700 feet. The property is equipped with a 10-stamp mill that operated during 1903 on ore from this mine averaging from \$10 to \$30 per ton.

The Barringer mine, which is 1 mile southwest of Gladstone, Stanly County, was developed in 1903 to the extent of 150 feet of shafts, 395 feet of drifts and 92 feet of cross-cuts. This makes the total amount of under-ground work to January, 1904, 1,060 feet, of which 204 feet were shafts, 681 feet drifts, and 175 feet of cross-cuts. The ore mined was treated at the mill of the McMakin mine. The deepest shaft on this property is now 175 feet. Both of these mines were producers of gold in 1903.

Besides these properties, the Whitney Company own the Yadkin and Virgilina Copper and Land Company, which is an organization resulting from the merger of a number of mineral properties located in the neighborhood of Virgilina, Virginia. The Yadkin Mines Consolidated Company was formed by the merger of the Old Russell mine and a number of adjoining properties located in Montgomery County. No work of any particular importance was done upon these properties during 1903, and it is the intention of the Whitney Company to postpone any active developments on these properties until the large operations that are being undertaken by this company at the Narrows of the Yadkin river are fully completed. As soon as the installation of the electric power plant is finished at the Narrows of the Yadkin, extensive development work and mining operations will be carried on by this company at their numerous properties in the surrounding districts of North Carolina.

The mine producing the most gold during 1903 was the Iola in Montgomery County. This mine is owned by the Iola Mining Company, who own a tract of land containing some 52 acres, which is located 2 miles northwest of Candor, a station on the railroad running from Ashboro to Aberdeen. The property has been opened by means of two shafts, one at an inclination of 45 degrees following the dip of the vein whose strike is N. E.-S. W. This shaft has been sunk 173 feet and from it five levels have been started. The second shaft is a vertical one and was started 225 feet from shaft number one. It has been sunk to a depth of 200 feet. At the 150-ft. level a cross-

cut has been made to the vein connecting with the drifts from shaft number one. The length of this cross-cut is 110 feet. This shaft will encounter the vein, if it holds its present dip, at a depth of 275 feet. The mine is equipped with a 20-stamp mill and amalgamating tables. A cyanide plant has been installed to treat the tailings and works satisfactorily. It has been estimated that there has been about \$165,000 in gold taken from this mine.

The Oak Hill Mine, near High Point, Guilford County, was developed during 1903 by the Oak Hill Mining Company with satisfactory results. While there has been thus far no shipment of ore or concentrates, it is expected that this mine will be one of the producers of gold in 1904.

The Enterprise Gold Mining, Milling and Investment Company is developing a property within a few miles of Burlington, Alamance County.

The Nibelong mine in Caldwell County, 11 miles north of Morganton, Burke County, and owned by the Blue Ridge Mining and Milling Company, was developed during the latter part of 1903 to the extent of sinking one shaft 75 feet deep, at which level one drift was run 60 feet to the northeast and another 55 feet to the southwest. The vein averages about 2 feet in width. The property is equipped with a 5-stamp mill.

The Nor-Lin Mining Company, which is developing a property near Silver Hill, Davidson County, North Carolina, is erecting a small stamp mill and other necessary equipment for treating the ore.

At the Colossus mine, which was formerly the Howie mine in Union County, the ore is being successfully treated by cyaniding and is proving satisfactorily that North Carolina's low-grade ores are susceptible to cyanide treatment.

From the amount of development work that is being carried on in the State on gold properties, as is indicated from what has been said above, there is every reason for expecting a large increase in the production of gold in North Carolina during 1904 over that of the previous year.

PRODUCTION.

The total production of gold and silver in 1903 was valued at \$130,511 (coining value), which is an increase of \$6,649 over that

of 1902, which was valued at \$123,862. Of this production, the value of the gold was \$113,604, an increase of \$19,954 over that of 1902, which was valued at \$93,650. The value of the production of silver in 1903 of \$16,907 (coining value) was a decrease of \$13,305 as compared with the value of the production of 1902, which amounted to \$30,212. This large reduction in the value of the silver production is due to the large falling off in the production of copper ores, as nearly all the silver is obtained from these ores.

The 1903 production of gold and silver was divided among 31 counties. The county producing the largest amount of gold was Montgomery with a production valued at \$48,635; while the smallest production was from Caldwell County, which is credited with a production valued at \$41.10. The county which was second in the production of gold during 1903 was Stanly with a production valued at \$24,524; while Mecklenburg was third with a production valued at \$8,578. The production of silver was obtained principally from Person, Rowan and Granville Counties, from which was also obtained nearly all of the copper produced in 1903. Person County, which produced the largest amount of copper, also produced the largest amount of silver, this being valued at \$8,632. Rowan County was second with a production valued at \$4,119 and Granville County third with a production valued at \$2,259. The combined value of the production of silver in these three counties is \$15,010; while the total value of all the silver produced in 1903 was only \$16,906, leaving but a value of \$1,896 as having been obtained from gold ores. This indicates the fineness of the gold that is mined in North Carolina. In the tables below there is given the production of gold and silver in North Carolina during 1903 and 1902 by counties:

PRODUCTION OF GOLD AND SILVER IN 1903 BY COUNTIES.*

COUNTY.	GOLD.†	SILVER.†	TOTAL.
Burke -----	\$ 1,606.44	\$ 17.09	\$ 1,623.53
Cabarrus -----	3,237.23	85.93	3,323.16
Caldwell -----	41.10	.87	41.97
Catawba -----	1,181.07	19.09	1,200.16
Cherokee -----	1,144.52	5.91	1,150.43
Clay -----	46.51	.29	46.80
Cleveland -----	5,269.40	1.16	5,270.56
Davidson -----	230.12	161.52	391.64
Franklin -----	162.79	2.48	165.27
Gaston -----	196.84	2.85	199.69
Granville -----	562.68	2,258.97	2,821.65
Guilford -----	3,806.62	159.16	3,965.78
Halifax -----	423.81	2.63	426.44
Henderson -----	186.05	2.33	188.38
Iredell -----	133.84	1.60	135.44
Lincoln -----	522.42	9.90	532.32
Macon -----	93.02	.58	93.60
McDowell -----	2,260.15	30.60	2,290.75
Mecklenburg -----	8,578.72	102.89	8,681.61
Montgomery -----	48,634.83	878.27	49,513.10
Moore -----	388.87	8.04	396.91
Nash -----	139.54	2.15	141.69
Orange -----	351.46	5.11	356.57
Person -----	1,096.15	8,632.24	9,728.39
Polk -----	602.21	4.22	606.43
Randolph -----	396.30	6.96	403.26
Rowan -----	1,852.39	4,119.21	5,971.60
Rutherford -----	1,322.20	16.91	1,339.01
Stanly -----	24,524.30	116.05	24,640.35
Union -----	3,101.84	95.68	3,197.52
Warren -----	139.54	1.75	141.29
Unknown -----	1,370.59	154.22	1,524.81
Total -----	\$113,603.55	\$ 16,906.66	\$ 130,510.11

*The gold and silver statistics have been obtained through the courtesy of Mr. Geo. B. Hanna, of the United States Government Assay Office, Charlotte, N. C.

†Coining value.

PRODUCTION OF GOLD AND SILVER IN 1902 BY COUNTIES.*

COUNTY.	GOLD.†	SILVER.†	TOTAL.
Burke	\$ 3,536.19	\$ 42.07	\$ 3,578.26
Cabarrus	1,049.30	87.20	1,136.50
Caldwell	18.60	.11	18.71
Catawba	1,544.93	15.97	1,560.90
Chatham	127.76	2.55	130.31
Cherokee	1,221.86	5.67	1,227.53
Clay	198.14	1.41	199.55
Cumberland	18.60	.11	18.71
Davidson	603.24	367.77	971.01
Franklin	625.77	6.24	632.01
Gaston	205.30	3.19	208.49
Granville	253.23	937.75	1,190.98
Guilford	929.45	36.57	966.02
Halifax	1,350.56	5.14	1,355.70
Henderson	490.19	10.63	500.82
Iredell	231.61	2.89	234.50
Lincoln	144.74	.54	145.28
Macon	93.02	.58	93.60
McDowell	2,048.85	36.63	2,085.48
Mecklenburg	20,439.58	860.41	21,299.99
Montgomery	38,498.15	675.00	39,173.15
Moore	542.75	19.55	562.30
Nash	292.24	6.79	299.03
Orange	504.70	18.71	523.41
Person	1,241.47	10,520.50	11,761.97
Polk	1,325.70	12.98	1,338.68
Randolph	1,064.48	11.30	1,075.78
Rowan	10,131.17	16,401.86	26,533.03
Rutherford	2,241.15	27.96	2,269.11
Stanly	862.03	5.00	867.03
Union	719.90	34.45	754.35
Warren	118.86	1.73	120.59
Unknown	976.78	53.21	1,029.99
Total	\$ 93,650.30	\$ 30,212.47	\$ 123,862.77

*The gold and silver statistics have been obtained through the courtesy of Mr. Geo. B. Hanna, of the United States Government Assay Office, Charlotte, N. C.

†Coining value.

As is seen from the above tables, Chatham and Cumberland counties, which made a small production of gold and silver in 1902, were not producers in 1903. Cleveland County was added to the list of producers in 1903, and is fourth in the value of its production of gold and fifth in the value of its combined production of gold and silver.

The production of gold in North Carolina since 1882 is given in the table below:

**GOLD AND SILVER PRODUCTION IN NORTH CAROLINA
FROM 1882 TO 1903.***

YEAR.	GOLD.	SILVER.	TOTAL.
1882 -----	\$ 190,000	\$ 25,000	\$ 215,000
1883 -----	167,000	3,000	170,000
1884 -----	157,000	3,500	160,500
1885 -----	152,000	3,000	155,000
1886 -----	175,000	3,000	178,000
1887 -----	225,000	5,000	230,000
1888 -----	136,000	3,500	139,500
1889 -----	145,000	3,878	148,878
1890 -----	118,500	7,757	126,257
1891 -----	95,000	6,465	101,465
1892 -----	78,560	12,671	91,231
1893 -----	53,600	17,325	70,925
1894 -----	46,594	455	47,049
1895 -----	54,200	520	54,720
1896 -----	44,300	646	44,946
1897 -----	34,600	388	34,988
1898 -----	84,000	905	84,905
1899 -----	34,500	388	34,888
1890 -----	44,653	15,986	60,639
1901 -----	60,410	34,023	94,433
1902 -----	93,650	30,212	123,862
1903 -----	113,604	16,907	130,511

*Coining value.

COPPER.

The production of copper ores in North Carolina in 1903 was considerably less than for the year previous, but there was, on the other hand, a considerable increase in the amount of development work that was carried on, which cannot but result favorably to the production of these ores during the next few years. The copper mine that has been worked the most extensively in the State was closed down during 1903 and the under-ground workings allowed to cave. This was the Holloway mine, which has been worked continuously from

1897 to 1904. During this period it has produced 16,695 tons of ore, from which there were obtained 1,613,550 pounds of copper, or 4.31 per cent. of copper to the ton of ore.

The Virgilina or Blue Wing District of Granville and Person counties was the scene of considerable mining and development work during 1903, and this district produced more copper than any other district in the State. The largest producer of copper in the district during 1903 was the old Yancey mine owned by the Person Consolidated Copper and Gold Mining Company, which is located about eight miles nearly south of Virgilina. This deposit is on a vein that is approximately parallel to the one on which is located the Holloway mine.

In this same district is the property of the Seaboard Copper Company, which is in Person County about 6 miles from Roxboro. This property has been developed by means of three shafts, 135, 200 and 105 feet deep respectively. From the 100-ft. level of the 200-ft. shaft, a drift 165 feet long has been driven, which connects with the 135-ft. shaft. On the 200-ft. level another drift is being driven to connect with the 135-ft. shaft, as this is sunk deeper. At the 100-ft. level of the 105-ft. shaft a drift has been started. It is estimated that there are on the surface about 1,200 tons of ore which will average approximately 6 per cent. copper.

The Salisbury Copper Company has re-opened what is known as the Holshouser mine, which is located near Crescent, Rowan County, about a mile from the Yadkin Railroad. A 5x10 vertical shaft is being sunk on the vein, and from it at a depth of 40 feet a cross-cut was driven across the vein which had a width of 15 feet. The vein is composed principally of quartz with auriferous copper and iron pyrites.

At the Gold Hill Copper mines, Rowan County, of which the Union Copper mine is the most extensively developed, there was but little work done during 1903, so that the production of copper and silver from this district was much less than during the previous year.

The Hercules Gold and Copper Company, whose property is at Cid, Davidson County, have been doing, during the past two years, as systematic development work as any other company in the State.

In this district the company own about 1,000 acres in fee-simple and have leased about 1,200 more. The copper deposit has been opened by means of 5 shafts which are approximately 40, 120, 180, 375 and 525 feet in depth respectively. Drifts have been driven at a number of levels from the shafts and a number of these are connected with each other. In carrying on this work as little ore as possible has been removed from the mine, and there has only been between 5,000 and 6,000 tons of ore raised to the surface. This is now on the dumps and will probably average 5 per cent. copper and about \$2 per ton in gold. The mine is equipped with a 50-ton water-jacket smelter and a concentrating mill. While this company made practically no production of copper in 1903, except what little was used for testing the value of the ore, they will, undoubtedly, during 1904, be added to the list of producers of both gold and copper in North Carolina.

The Twin-Edwards copper mine is in Guilford County, about one-half mile southwest of Greensboro and within one mile of the main line of the Southern Railway near Pomona. This property has not been worked since 1861, but during the past year it has been re-opened and some promising results as to the quantity of ore have been obtained. A sample of this ore, which was assayed at the laboratory of the Survey, gave the following results:

ASSAY OF ORE FROM TWIN-EDWARDS MINE.

	PER TON.	VALUE PER TON.
Gold -----	.343 oz.	\$ 6.86
Silver -----	Trace	
Copper -----	.8790	1.74

At the Everett mine, which is about 1½ miles from Medlin P. O. and 1½ miles from the junction of Sugar Fork creek and Hazel creek, no work was done during 1903 on account of litigation. This property has been systematically prospected and preparations were being made for the erection of reduction works for treating the ore, which will undoubtedly be completed as soon as the lawsuit is settled. In the upper workings of this mine some native copper and

considerable tenorite, the black oxide of copper, have been found. From one drift about 20 tons of this oxide of copper were taken out. It has been estimated that there are between 8,000 and 9,000 tons of ore on the dumps that were taken out during the development work. The property is equipped with four Rand drills, compressors, engines, boilers, etc., and all necessary tools for the employment of 125 men. Near the Everett mine on Hazel creek the Westfeldt Brothers of New Orleans are systematically developing a copper property to block out a certain tonnage of ore. The ore body carries from 4 to 5 per cent. copper, with some values in gold and silver.

There was a small amount of development work done in Jackson County on the properties of the Carolina Copper Company and the Cullowhee Copper Company in the central part of the county near Cullowhee, North Carolina. There was no production of copper, however, and the properties are still in the nature of prospects.

There was no work whatever done in the Ore Knob Copper District of Ashe County or the Peach Bottom Copper District of Alleghany. One of the main difficulties of operating these copper deposits in Alleghany and Ashe counties is their distance from railroad transportation as well as their distance from fuel.

PRODUCTION.

The total production of copper in 1903 was 438,133 pounds, valued at \$67,037. This is less than one-third the production of 1902, which amounted to 1,417,020 pounds, valued at \$212,553. This is also a decrease of 54,533 pounds in quantity and of \$9,863 in value as compared with the production of 512,666 pounds, valued at \$76,900, in 1901. The total tonnage of crude ore mined in 1903, from which the 438,133 pounds of metallic copper were obtained, was 4,106 tons. This ore contained from 3 to 27 per cent. of copper and a large part of it was concentrated before shipment.

Considering the amount of development work that was done in 1903, there should be a considerable increase in the production of copper in 1904 over that of 1903. In the following table there is given the production of copper for the years 1901, 1902 and 1903:

PRODUCTION OF COPPER IN NORTH CAROLINA IN 1901, 1902 AND 1903.

YEAR.	CRUDE ORE MINED.	COPPER PRODUCED.	VALUE.
	TONS.	POUNDS.	
1901 -----	10,398	512,666	\$ 76,900
1902 -----	16,741	1,417,020	212,553
1903 -----	4,106	458,133	67,037

IRON.

The iron deposits of North Carolina were worked more extensively during 1903 than for many previous years. The Cranberry mine, at Cranberry, Mitchell County, owned by the Cranberry Furnace Company, continues to be the largest producer of iron ore. This mine, which furnishes magnetic iron ore, is the most famous mine in the State and has been the only constant producer of iron ore. It furnishes a pig iron of superior quality.

The Wilson mine, at Wilson's Mills, Johnston County, was worked almost continuously for the first six months of 1903; but then, owing to the shutting down of the Greensboro furnaces, the mine also was obliged to close down. The ore obtained from this mine is a limonite containing, according to the analyses of the average run of ore, as follows:

COMMERCIAL ANALYSES OF LIMONITE ORE FROM WILSON MINE.

Metallic iron -----	49 to 51 per cent.
Phosphorus -----	.3 to .55 per cent.
Sulphur -----	None.
Manganese -----	Trace to .3 per cent.
Silica -----	4 to 18 per cent.

The body of ore is apparently large, and if the smelter at Greensboro should again start up this mine would undoubtedly once more become a producer of iron ore.

There was no production of iron ore from the Madison County deposits during 1903.

The litigation over the Ballou iron mine, which has been going on for a number of years, has finally been settled, and it is now very probable that this property will again be opened up, as it contains a large quantity of ore of good quality. It is but about 60 miles from

this property to the West Virginia coal fields, and if the projected railroad from these coal fields to the coast is built it will bring these iron mines in easy communication with the coal fields, which would be the means of their being developed on a large scale and the erection of furnaces for the reduction of the ore.

The deposits of limonite iron ore at Ore Hill, Chatham County, were worked to some extent during 1903, the ore being shipped to the furnace at Greensboro.

PRODUCTION.

The blast furnace at Greensboro, Guilford County, North Carolina, operated by the Empire Steel and Iron Company, was put in operation in January, 1903, and was run less than half the time until October 19, when it was blown out indefinitely. During this period there was used 17,984 tons of ore. The shutting down of this furnace means the closing down of the mines in Johnston and Chatham counties, as these ores cannot be shipped at a profit to other furnaces.

The total production of iron ore in 1902 was 82,881 tons, valued at \$78,540. This is an increase of 48,545 tons in quantity and of \$25,769 in value as compared with the production of 34,336 tons, valued at \$52,771, in 1902.

PYRITE.

Until 2 years ago pyrite was mined to a considerable extent in North Carolina, the principal deposit being the Oliver mine, 4 miles from Crouse, Gaston County. Since, however, this mine passed into the possession of the Virginia-Carolina Chemical Company, it has been shut down. In 1903 there was no production whatever of pyrite for use in the manufacture of sulphuric acid.

TIN.

The mineral cassiterite, tin oxide (SnO_2) containing 78.6 per cent. of metallic tin, is the only commercial source of the metal tin. This mineral is found in North Carolina in what is known as the Kings Mountain district, which extends across the southeastern corner of Cleveland County and across Gaston and Lincoln counties. From Grover, South Carolina, a station on the Southern Railway, to within a few miles of Lincolnton, Lincoln County, North Carolina, a distance of over 14 miles, tin ore has been found almost continuously,

and it is reported to have been found a few miles northeast of Lincoln; but no authentic record of this discovery can be obtained. The principal deposits that have thus far been located are in the vicinity of the town of Kings Mountain; on the southern end of Chestnut Ridge, about $2\frac{1}{2}$ miles northeast of Kings Mountain; and on the John E. Jones plantation, 7 miles northeast of Kings Mountain.

The Southern Railroad passes over a considerable portion of the tin belt, following almost the general direction of the formation from Kings Mountain to Gaffney, South Carolina. At the former place the railroad turns sharply to the east, crossing the tin belt, which continues toward the northeast. Thus, any commercial deposits that may be developed will have good railroad facilities, not being more than a few miles from the railroad. Those on Chestnut Ridge are not over 2 miles from the railroad, and the ore mined could easily be hauled to the railroad at small expense. If the Jones deposit proves to contain tin in any large quantity it would still be profitable to haul the ore to the railroad at Bessemer City, a distance of about 4 miles, if it did not prove feasible to build the railroad to the deposits.

In order to obtain some idea of the percentage of cassiterite that the veins contain, a sample was taken across a $2\frac{1}{2}$ -foot vein at the Jones mine which gave, on crushing and panning, a concentrate of practically pure cassiterite representing from 5 to 6 per cent. of the vein. This would represent about $3\frac{1}{2}$ per cent. of metallic tin. An ore carrying such a percentage of tin would, if in quantity, make a profitable proposition. Favorably located deposits have been worked that did not carry over $1\frac{1}{2}$ per cent. of metal.

There was considerable prospecting done during 1903 on the North Carolina tin deposits and a ton or more of tin concentrates obtained. A full description of the Carolina tin deposits is given in the recent report published by the North Carolina Geological Survey on the Carolina Tin Deposits, which is published as Bulletin No. 19.

ABRASIVES.

The abrasive materials are among the most important of the minerals mined, and their production depends largely upon our manu-

facturing industries. Any decided increase in manufacturing will cause an increase in the amount of abrasive materials used, and although there may be a decrease in some particular abrasive, there will be a corresponding increase in some other. The abrasive materials are readily divided into three groups, as follows:

1. Those which occur as a rock formation and are cut and manufactured directly into the form desired while retaining their original rock structure and appearance, as grindstones, scythestones, etc.

2. Those which occur as a constituent of either a rock or a vein and have to be mechanically separated from the associated gangue and cleaned, as corundum, garnet, etc.

3. Artificial abrasives, as carborundum, crushed steel, etc.

The abrasive materials constituting these three groups are oilstones and scythestones, grindstones and pulpstones, buhrstones and millstones, pumice, infusorial earth and tripoli, crystalline quartz, garnet, corundum and emery, feldspar, carborundum, crushed steel, artificial corundum and adamite. Of the above those that are found in North Carolina are materials for making buhrstones and millstones; suitable material for grindstones and whetstones, quartz, garnet, corundum and emery. Of these, however, the only ones that have been mined for abrasive purposes during recent years are garnet, corundum and millstones.

CORUNDUM.

The corundum deposits of North Carolina were the first to be worked for this mineral in the United States, and for a number of years this State produced all of the corundum (except emery) used in the United States. Until within the last three years North Carolina had been the largest producer of corundum of any State in the country.

For the past few years, however, there has been but very little corundum mined, and during 1903 the only production of corundum was by the North Carolina Corundum Company, whose property is located at Buck Creek, Clay County. They have erected a large and complete mill for cleaning and sizing their corundum ore, which will make a very pure and efficient corundum. As this company was the only producer of corundum, their statistics are included in the total production of abrasives and are not given separately.

GARNET.

A new locality for garnet for abrasive purposes was partially developed in 1903 in Madison County by Mr. M. F. Drudy. The deposit is located on Little Pine creek, near Marshall, Madison County. The garnet crystals, which are of the almandine variety, occur in a band of chloritic schist about 20 feet wide, that can be traced across country for a distance of about 1 mile. The noticeable feature of this deposit is the remarkable size of the crystals, which average at least 2 inches in diameter, some having been found $7\frac{1}{2}$ inches in diameter. The crystals, though usually elongated, are well developed and dodecahedral in character. They are usually slightly altered on the exterior surfaces to chlorite, but on the interior they are sound and break with a clean, sharp, cutting edge. They are readily separated from the enclosing rock, and a pure garnet product is easily obtained. None of this garnet was mined in 1903; but mining operations were begun early in 1904, and the product already shipped has been received very favorably. On account both of the ease with which this garnet can be mined and separated and of its quality, it should readily be able to compete with any other garnet. The property is well located for railroad transportation facilities, being on the main western line of the Southern Railway, running from Salisbury, N. C., to Chattanooga, Tenn. While there was no production of garnet from this locality, sufficient work has been done to demonstrate the existence of a large quantity of the garnet and that it can be mined and cleaned and prepared for market in competition with garnet from other localities. Its abrasive efficiency is equal to the New York or Connecticut garnet.

The production of garnet in 1903 was from the Sugar Loaf mine near the summit of Sugar Loaf Mountain, Jackson County, about $1\frac{1}{2}$ miles from Hall, a station on the Murphy branch of the Southern Railway. The production is not given separately, but is included under the total production of abrasives.

MILLSTONES.

For a great many years, millstones or buhrstones have been manufactured in the mountain sections of the State for local purposes. It is, however, only within the past three years that any attempt has

been made to produce a millstone for commercial purposes. These stones are now being made out of the granitic rock which occurs at Faith, Rowan County, and these are manufactured by Mr. J. T. Wyatt and Mr. F. J. D. Fisher, both of Faith. The production of these stones for 1903 was 63 pairs, valued at \$902, which were sold principally in North Carolina and Georgia. The demand for millstones or buhrstones has been increasing during the past few years for use in grinding the coarser cereals, mineral paint ores, fertilizers, cement rock, barytes and other minerals; and for which purposes the Rowan stone should give good satisfaction. Formerly millstones were used in very great number, principally for grinding wheat, but with the introduction of the roller-mill process there was a large falling off in the demand for the natural stone.

PRODUCTION OF ABRASIVES.

The combined production of garnet and corundum in 1903 amounted to 403 tons, valued at \$12,250, as compared with 260 short tons, valued at \$10,040, in 1902. This is an increase of 143 tons in quantity and of \$2,210 in value. The production of 63 pairs of millstones, valued at \$902, makes the total value of the production of abrasive materials in 1903 \$13,152, as compared with a total value of \$11,465 in 1902, an increase of \$1,687. The production of these abrasive materials for 1901, 1902 and 1903 are given in the following table:

PRODUCTION OF ABRASIVE MATERIALS IN 1901, 1902, 1903.

KIND.	1901.		1902.		1903.	
	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.
	TONS.		TONS.		TONS.	
Corundum -----	325	\$ 48,840			} 403	\$ 12,250
Garnet -----	775	43,000	260	10,040		
	PAIRS.		PAIRS.		PAIRS.	
Millstones -----			50	1,425	63	902
Total -----		\$ 91,840		\$ 11,465		\$ 13,152

MICA.

The demand for North Carolina mica is still in excess of the supply that is produced each year. On account of the comparatively low price at which mica is selling at the present time, which is especially true of the very large sheets which formerly brought very high prices, there is not the same interest in mica mining in the State as there was a decade ago. The new uses of mica for insulating purposes in electrical apparatus, which has created this large demand for mica, does not require the finest quality of mica like that obtained from North Carolina, and as the phlogopite mica from Canada and that obtained from India give just as good satisfaction and can be imported at a very cheap rate, it cuts down the price of North Carolina mica for these purposes. For stoves, lamp chimneys and for every purpose where a perfectly clear, transparent mica is required, it is the North Carolina mica that is in demand. For these purposes alone, however, there is not a sufficient market at a high enough price to support the mica mines without the production of the small electrical sheets and scrap mica as by-products. For these reasons it is often a question with the small producer whether he can make his mine a financial success or not. Where, however, the production of mica is carried on on a large scale so that a quantity of it can be kept on hand, including the large sheets for stoves, lamp chimneys, etc., the small electrical insulator sheets, disks, etc., and ground scrap mica, to supply all exigencies of the market, the mining should make a profitable investment. It is necessary, however, to mine in a very conservative manner and to utilize every scrap of the mica. There is at times an opportunity of obtaining other minerals as by-products in connection with the mica, such as quartz and feldspar, to be used for pottery purposes; beryls for gems; and uraninite or pitch-blende for its radium contents.

Where formerly a large proportion of the scrap mica produced and put on the market was obtained from old dumps and piles of scrap mica, which were thrown away during mica mining of 20 or 30 years ago, when there was no demand at all for it, at the present time a considerable proportion of the scrap mica is that obtained as waste during the present mining, and also as scrap from the cutting of sheet mica. Thus, as would naturally be expected, there has

been a constant decrease in the production of scrap mica for the past few years, as many of the old dumps and piles of scrap mica have been thoroughly worked over and their scrap mica utilized. There has, however, been a constant increase in the production of sheet or plate mica during this same period.

PRODUCTION.

The total production of plate mica in North Carolina during 1903 has been estimated at 385,000 pounds, valued at \$86,300, this being an increase of 55,534 pounds in quantity and of \$4,647 in value as compared with the production of 1902 of 329,466 pounds, valued at \$81,653. The scrap mica produced in 1903 has been estimated at approximately 300 tons, valued at \$2,400, a decrease of 24 tons in quantity but an increase of \$181 in value as compared with the production of 324 tons, valued at \$2,219, in 1902. In the following table there is given the approximate value of the production of sheet mica by counties for the years 1900 to 1903, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA DURING 1900, 1901, 1902 AND 1903 BY COUNTIES.

COUNTY.	1900.	1901.	1902.	1903.
Ashe -----	\$ -----	\$ -----	\$ -----	\$ 1,000
Buncombe -----			250	300
Haywood -----	11,000	11,500	20,000	18,000
Jackson -----	7,000	8,740	5,700	5,500
McDowell -----	1,000	500	600	1,000
Macon -----	5,200		4,000	3,500
Mitchell -----	26,722	33,506	28,203	29,000
Stokes -----	1,000		1,000	7,500
Transylvania -----	500	600	750	500
Yancey -----	12,788	25,003	21,150	20,000
Total value -----	\$ 65,200	\$ 79,849	\$ 81,653	\$ 86,300

QUARTZ.

PRODUCTION.

The mineral quartz is mined for a variety of purposes, such as the manufacture of glass and pottery; for abrasive purposes; as a flux and for gem purposes. In North Carolina the only direct mining for quartz is for use as a flux in copper smelting. Some quartz is found

which is used for cutting into gems and ornaments. The quartz in North Carolina that has been mined for flux in copper smelting has been obtained from near Ranger, Cherokee County, which is a station on the Atlanta, Knoxville and Northern Railroad; and from the Holloway mine, Person County. The quartz from Cherokee County has been used by the smelters of the Tennessee Copper Company at Ducktown, Tenn., and that in Person County by the Norfolk smelters. The total production of quartz during 1903 was 29,462 tons, valued at \$36,827, as compared with the production of 4,500 tons, valued at \$11,250, in 1902. This is an increase of 24,962 tons in quantity and of \$25,577 in value.

PRECIOUS STONES.

There is a great variety of gem minerals found in North Carolina at many different localities, principally in Mitchell, Macon, Yancey, Iredell, Lincoln, Alexander, Burke and McDowell counties. In Mitchell County there are found many varieties of beryl, including the aquamarine, golden and yellow beryls, blue beryl, emerald beryl and emerald matrix. The blue beryl is a very handsome gem and its color and brilliancy make it a very attractive stone. This blue color in the gem beryl is not common, and adds considerable to the value of the stone. The deep golden beryl is another very attractive stone, for which there is a considerable demand, and it is also obtained in Mitchell County in some quantity. The yellowish beryls that are found here vary from light straw through pale yellow, golden, to a deep yellow color. The emerald matrix stones continue to attract a great deal of attention, and there is a considerable demand for the emerald beryl cut in this manner, which is cut similar to the turquoise matrix gems. Some of the emerald beryl, which is not perfectly transparent, but is still of a decided emerald color, is cut *en cabochon*, and it makes very handsome green gems. A few stones are obtained that are transparent and these are put on the market with the brilliant cutting. These gems are obtained for the most part in the vicinity of Spruce Pine, and the company producing the largest amount of them is the American Gem and Pearl Company of New York. The principal gems found in Yancey County are the aquamarine beryl, some of the largest having been obtained from the

Ray mine near Burnsville. In Macon County there is a greater variety of gem minerals found, including many of the corundum gems, principally the ruby and sapphire, rhodolite, pyrope and almandine garnets; and aquamarines and golden beryls; and amethysts. The rhodolite, however, is the gem that is mined the most extensively in this county, and the American Gem Syndicate of St. Louis, Mo., is the largest producer. In Alexander County are found emerald beryls, hiddenite, quartz and rutile gems. In Iredell County the gem that is found in the largest quantity is the amethyst, and some of the finest found in the State are obtained from this county.

The demand for these semi-precious stones, as the rhodolite, beryl, etc., is constantly increasing and they are taking a place in the gem industry such as they have never done before, and the largest dealers in gem material are now putting on the market many of these semi-precious stones which formerly they would not handle at all. One reason, perhaps, for this is that these stones have a distinct color and character of their own and make up into the most attractive jewelry; and as they are brilliant and beautiful they are becoming to be appreciated for their real value, especially as the public is beginning to recognize them as distinct gems and not as imitations of others.

PRODUCTION.

There was but very little systematic mining for gems during 1903 and most of this work was confined to Mitchell County. The total value of the gems produced was \$1,525, which is a decrease of \$3,775 as compared with the value (\$5,300) of the production in 1902. There was but a very small production of the rhodolites, which is not due to the lack of demand for these stones, or, as far as can be learned, to the exhaustion of the deposits.

RARE MINERALS.

With the discovery of radium there has been considerable interest centered in the pegmatitic dikes of Mitchell County, which contain the uranium mineral, uraninite, or, as it is commonly known, pitchblende, the mineral from which all of the radium has been obtained. The mine that has produced the largest amount of this mineral is the Flat Rock mine near Spruce Pine, with smaller amounts from the

Buchanan, Wiseman and Deake mines. A small amount has also been found at the Ray mine, Yancey County. In comparing the pitch-blende found at Flat Rock mine with that from other localities, especially that from Bohemia, it was found that this Flat Rock pitch-blende showed a greater radio-activity than any of the others. This determination was made by Dr. B. B. Boltwood* of New Haven, Conn. At the Flat Rock mine there seem to be certain portions of the vein which contain the pitch-blende in some quantity, while in other portions a considerable distance may be traversed without encountering any of this mineral. As it is not evenly distributed in the pegmatitic dike, it is impossible to determine what percentage of this mineral could be obtained from systematic working of this mine. This mine has not been in operation for a number of years; but during the early working of the mine pitch-blende was thrown away. With the discovery of radium and the consequent demand for pitch-blende, the old dumps of this mine have been pretty thoroughly worked over by the people in the vicinity in search of this mineral, with the result that a good many pounds have been sold during the past year, the price rising from \$1 to \$9 per pound during the year. There are a number of other uranium minerals found in these pegmatitic dikes, some of which, such as the gunninite, are surrounding the pitch-blende as an outer covering and have resulted from its direct alteration.

Samarskite, which is a mineral containing many of the rare earth metals, and also a small percentage of uranium, has been found in considerable quantity in Mitchell County, principally at the Wiseman mine. The demand for this mineral is not large, but during the past year the small amount that was obtained was sold readily at from 50 cents to \$1 per pound, according to the purity of the mineral.

PRODUCTION.

The total production of these rare minerals during 1903 was valued at \$270, the greater part of which was the value of the uraninite (pitch-blende).

*At the laboratory of Pratt & Boltwood, 139 Orange Street, New Haven, Conn.

MONAZITE AND ZIRCON.

INTRODUCTION.

On account of monazite and zircon being mined for similar purposes—*i. e.*, for the rare earth oxides that they contain—they are treated together in this report. The oxides obtained from these minerals are used in the manufacture of mantles for various incandescent lamps and for the glowers of electric lamps. The demand for monazite is increasing and considerable of that mined in the State is now being exported to Germany. All of the zircon mined, however, is consumed in the United States in the manufacture of the glowers for the Nernst electric lamp.

MONAZITE.*

Monazite, which is essentially an anhydrous phosphate of the rare earth metals, cerium, lanthanum and didymium, usually contains a varying but small percentage of thoria. It is the presence of this latter oxide that gives the monazite its commercial value. There is a very wide variation in the percentage of thoria that the monazite contains, but the commercial monazite that is put on the market contains from 3 to 9 per cent. of this oxide. The thoria, together with very small amounts of lanthanum and didymium oxides, are used in the manufacture of the cylindrical hood or mantle of the Welsbach and other incandescent gas lights. The cerium oxalate obtained in the separation of the other oxides, is used to a limited extent in pharmacy.

Monazite varies considerably in color, being light yellow to honey yellow, reddish, brownish and yellowish green, and has a resinous to vitreous luster. It is brittle, breaking with a conchoidal or uneven fracture, and is from 5 to 5.5 in hardness. The mineral is heavy, having a specific gravity of 4.64 to 5.3. By means of its color and specific gravity it can usually be readily identified.

Localities.†

Commercial deposits of monazite are not found in the original rocks, but in the gravel deposits of the present and former streams,

*United States Geological Survey: Mineral Resources of the United States, 1903.

†In the field work assistance has been rendered by Mr. Douglass B. Sterrett of Yale University.

which have resulted from the disintegration and erosion of the crystalline rocks which contain the monazite. These rocks have been altered and decomposed to a considerable depth, so that at the present time they are in a state of constant erosion; and their mineral constituents, monazite, zircon, magnetite, etc., are being deposited in the soils and gravels. This is going on to such an extent that even after the soils and gravels have been once worked for monazite, they may be re-washed at the end of the year and prove profitable sources of monazite.

The supply of monazite is obtained from Cherokee and Spartanburg counties, South Carolina, and from Rutherford, McDowell, Burke, Cleveland and Lincoln counties, North Carolina. There are large numbers of small miners in most of these counties who produce from a few pounds to a ton of monazite per year. Many of these do not concentrate their product beyond that effected by sluice-boxes, and they sell their material to some one of the four companies who are buying monazite, either for their own use or for exportation. These concentrates vary considerably in color, according to the locality from which they have been obtained, and there are consequently monazite concentrates of a red, red-brown, brown, yellowish brown, yellowish green and yellow color.

Rutherford County.—One of the main centers of the monazite mining industry in the State is Ellenboro, Rutherford County. Near this place is located the property of the German Monazite Company. This company is working 26 or more men, who wash out about $1\frac{1}{2}$ tons of cleaned sand each week. Their workable gravel is from 20 to 100 yards wide and extends for half a mile up and down the creek. The overburden, which has to be removed, is from 1 to 5 feet in depth, some of which carries a small amount of monazite.

Three miles from Ellenboro, at the Louisa Smart mine, three different colored monazite sands are found, which are not more than 100 yards apart, one being of a greenish color, another brownish red, and the third yellowish. The first is found along the small branch just above the drying plant, the second is found higher up on the hill-side, about 60 feet from the stream. These two gravels are being sluiced on but a small scale at the present time. These gravels pan well and were quite free from garnet, and contained but

a little of the black sand. The gravels are 3 feet thick, and are covered by 2 to 3 feet of an overburden of red clay. The third, or yellowish monazite sands, are now being washed; but they contain some garnet and heavy iron minerals. The brownish sand readily concentrates to a product containing 80 per cent. monazite. This property would be more extensively worked but for the lack of a sufficient water supply. Near these gravel deposits, a pegmatitic dike 4 feet in width was observed cutting the hornblende gneiss. This dike contained a great many garnets up to the size of a walnut and also monazite, which was proved by panning the crushed rock.

There are several places near Ellenboro where monazite is being mined. One is on the property of Mr. E. A. Martin, where a good percentage of monazite is obtained in panning the stream gravels and also the gravel for some distance under the banks; but the total area of the pay gravel is not large. Another is on the west fork of Sandy Run creek, on the land of Mr. J. C. Glover, where there is a considerable quantity of gravel, but it did not show a very large percentage of monazite on panning. The gravels are from 2 to 3 feet in thickness under an overburden of from 1 to 2 feet. There is, however, a good water supply which is favorable for working the gravels in quantity. Only two sluice-boxes were worked during the past year on this property. Again, on a small tributary of Sandy Run creek, on the land of Mr. J. D. Bridges, the stream-gravel and the gravel and soil on the banks are exceedingly rich in monazite, but the area of the gravels is not very extensive.

Three miles southeast of Ellenboro, on a small branch running through the plantation of Mr. D. B. Farrill, the gravels have been pretty well worked out once and are now being worked over the second time, yielding fairly good results. Only one sluice-box, however, was being worked during 1903, although there was a sufficient water supply for using several.

At Rutherfordton is another center of monazite mining and on the land of Mr. A. D. K. Wallace, 2 miles from Rutherfordton, considerable work has been carried on. The gravels in the bottom-land are often 100 feet across and from 1 to 3 feet thick. The overburden, which is not very heavy, contains some monazite and is washed similarly as the gravels. There are two branches on this

property containing workable gravel deposits, varying from 50 to 150 feet in width and about a quarter of a mile in extent. There is a good water supply on this property. About half a mile west of the Wallace deposits, on the land of Mr. H. Harris, the gravels that extend up and down the stream for a distance of nearly a mile have been washed. At Peppertown creek, where some mining has been done for monazite, the concentrates are low in monazite, being made up largely of black magnetic sand.

At Duncan, 17 miles from Ellenboro, on the land controlled by Mr. Henry Gettys, there are 30 acres of bottom-land, extending about a mile along the stream, which contain considerable monazite. The stream-gravels are to be washed first and then the bottom-land. Six or eight troughs will probably be used. In the same vicinity, on the land of Mr. S. A. Mode, the stream-gravels and bottom-gravels contain considerable monazite and there is a good supply of water.

Cleveland County.—On the land of Mr. A. M. Hunt, 6 miles from Casar, Cleveland County, there were two sluice-boxes operated in 1903, although the gravel deposits would warrant more, and there was an abundant water supply with which to develop them. The gravels panned very well, showing a good percentage of monazite. They varied in thickness from 2 to 3 feet, and there was good width of bottom-land that had only been partially worked out. Near the upper end of this land the stream-gravels are profitable to work over a number of times, as there has been no work done on the adjoining property and the rains are constantly bringing down new sources of supply of monazite.

In the vicinity of Carpenter's Knob, Cleveland County, there are some very promising gravel deposits containing monazite, a number of which are being worked by the Incandescent Light and Chemical Company of New York City. On the land of Mr. J. C. Crow, the bottom-land gravels are from 30 to 75 yards wide and will average about 2 feet in thickness. During 1903 there were 2 sluice-boxes at work on these gravels and 2 on the land of Mrs. Eliza Spakes further up the stream. These lands are on the head-waters of Little Knob creek. Further down on the creek, on the McSneed property, the monazite gravel was observed in one place to be 7 feet thick. Two sluice-boxes were in operation on this property, but there is a

sufficient supply of water to work more, which would be warranted by the quantity of gravel. Little Knob creek has been worked more or less from near its source to its mouth, but in many places the gravels have received new supplies of monazite, so that it will pay to wash them again. On the property owned by the Incandescent Light and Chemical Company, five sluice-boxes were operated in 1903 and the stream-gravel will be worked for about a mile. In a number of instances, bottom-gravels that had formerly been washed are now being washed again and at a profit. The gravel in some places is 5 feet in thickness. This company also own and are working monazite gravels on Camp creek in Burke County, and the Lattimore mine near Shelby, Cleveland County. They expect to erect a concentrating or cleaning mill near Carpenter's Knob. Another good deposit of stream-gravel and bottom-land gravel is on the land of Mr. W. E. Ledford, near Carpenter's Knob. These gravels pan very well and there is a good water supply.

On Knob creek there are very extensive stream-gravels and considerable bottom-land gravels which, while they do not contain a very large percentage of monazite, are extensive in area, and as there is a good water supply they could be worked on a large scale and therefore could be mined profitably.

Near Mooresboro, Cleveland County, there are a number of small producers of monazite. The most work is done on the land of Mr. H. C. Burrus, who operated three sluice-boxes or troughs in 1903. There is a considerable area of bottom-lands, but only small portions of these are being washed for the monazite. The branch flowing through this property has been worked for a distance of about a mile and contains workable deposits of 100 yards in width. The concentrates, however, contain a rather large percentage of the black sand.

Burke County.—In Burke County, on Brindletown creek and its tributaries, are many properties containing good deposits of monazite gravels, such as those of Captain J. E. Mills, Mr. John Kirksey and Mr. Moore Epley.

McDowell County.—In McDowell County, there are numerous good deposits of monazite on the waters of Muddy creek, but an act of the Legislature prohibits the use of these streams for sluicing pur-

poses, and thus prevents the mining of monazite on the adjacent properties.

There is a tendency among a large number of the farmers who own lands containing monazite gravels to work only the stream-gravels, which they do two or three times a year, leaving the bottom-land untouched except for farming. The heavy rains wash the sands in from the hill-sides, from under the banks and from the streams above, thus renewing the monazite in the stream-gravel. These surface soils seem to contain a considerable per cent. of monazite for 6 or 8 inches of their depth, which has resulted from the decomposition and disintegration of the adjacent rocks. The sands that are obtained from the sluice-boxes are sometimes re-washed by the miners, but usually it is sold directly to some one of the companies owning the concentrating plants.

Methods of Drying Monazite Concentrates.

The weighed concentrates are dried in two different ways. One way consists of spreading the sand over an oiled or rubber cloth in the sun, where it dries very quickly, due partly to the heat absorbed by the dark iron sand. The other method of drying is by heating over a furnace. A small ditch from 4 to 8 feet long and 1 to 1½ feet wide and about 1 foot deep is dug, at one end of which there is built a rock or brick chimney. Over the ditch there is a sheet-iron cover. The monazite is spread out on this sheet-iron drying-plate, under which there is a hot fire.

Concentrating Mills.

The concentrating mills that are now being operated in the monazite district are those of the Carolinas Monazite Company, located at Shelby, Cleveland County, North Carolina, and Gaffney, Cherokee County, South Carolina; that of the German Monazite Company at Oak Springs, Rutherford County; and that of the Incandescent Light and Chemical Company near Carpenter's Knob, Cleveland County.

Further cleaning of the concentrates that are obtained from the sluice-boxes by the miners has been perfected to such an extent that now a cleaned monazite sand can be obtained that is from 95 to 99 per

cent. monazite. This has been effected by means of the Wetherill Electro-magnetic Separator. The dried concentrates are placed in a hopper and from there fed to a classifier. The finer material, which contains the monazite, is allowed to pour over a revolving drum, and is thus scattered evenly over an 18-inch belt. This passes along under four powerful electro-magnets, which have small belts to carry the material attracted by the magnets out of the magnetic field. As soon as such a point is reached, the belt drops the sand, which passes through a chute to the proper receptacle, placed to receive it. The first magnet removes all the magnetic iron, the larger pieces of garnet and generally all of the titantic iron or ilmenite. If any of the latter passes this belt it is removed with all of the finer garnet sand by the second magnet. The third magnet is so adjusted as to remove only the coarse monazite, and the fourth removes all of the finer pieces of monazite. The remaining sand, quartz, zircon, rutile, etc., is dropped off the end of the large belt and is run into the waste pile.

The garnet, which is of very good quality, having a hardness of 7.5, will, if it is obtained in some quantity, be of value for abrasive purposes. There is some gold contained in these tailings, but no attempt is made to save it.

In washing some of the monazite gravels, the gold which they contain is saved and in many instances has amounted to \$1 or more per sluice-box per day.

ZIRCON.

The mineral zircon is a silicate of zirconium (ZrSiO_4) and is commonly found in square tetragonal prisms terminated by the pyramid. It is usually of a grayish, light brown to a reddish brown color. Occasionally it is found colorless to red and perfectly transparent, when it becomes of value as gem material. In hardness it is 7.5 and has a specific gravity of 4.65. Besides the use that is made of the transparent varieties of this mineral for gems, there is a certain amount that is mined for its zirconia content. This oxide is used together with yttria in the manufacture of the glower for the Nernst electric lamp.

Occurrence and Localities.

Zircon is commonly found sparingly in the crystalline rocks, especially gneisses, syenites, granites, in granular limestones, and in chloritic and other schists. Occasionally it is found associated with some of the iron ores. Occurrences of this mineral in quantity are not common, and there is but one locality in the United States where it has thus far been found in commercial quantity and that is in the vicinity of Zirconia, Henderson County, North Carolina. The zircons occur in a pegmatitic dike which is about 100 feet wide and has a strike of N. 50° E. It cuts up through the old Archean gneisses, and can be traced for a distance of about 1½ miles. The upper portions of the pegmatitic dikes are badly decomposed and kaolinized to a depth of 40 feet or more. The zircons occurring in these dikes are of a grayish color and well crystallized, prismatic crystals terminated by the unit pyramid predominating. They occur for the most part in the feldspar, and where this is kaolinized it permits of an easy separation of the zircon crystals by hydraulic processes. As the feldspar becomes more solid and unaltered, the separation of the zircon is more difficult. In crushing the feldspar, however, the zircons readily free themselves from the gangue. There are two deposits of these zircon crystals that have been worked; one near the southwestern end of the pike, which is known as the Freeman mine, and the other near the northeast end, which is known as the Jones mine. Owing to the slight demand for this mineral, there is no systematic mining carried on. Men and children are paid a certain price per pound for the zircon crystals, some of which they wash out of the soil, others out of the kaolinized gangue, and still others they break out by hand from the harder feldspar. The resultant product contains practically 100 per cent. of zircon.

Near New Sterling, Iredell County, a great many brownish, pyramidal crystals of zircon have been found in the soil, some of which were 1 to 3 inches in diameter. One crystal weighed about 6 ounces. The exact occurrence of these crystals has not as yet been definitely determined, but thus far there has been observed no indication of a commercial quantity.

There are small quantities of zircon found in all the monazite sands, which could probably be saved as a by-product. These crystals are very minute, and are transparent.

PRODUCTION.

The total production of monazite in North Carolina during 1903 was 773,000 pounds, valued at \$58,694, which is a decrease of 29,000 pounds in quantity and of \$5,466 in value as compared with the production of 802,000 pounds, valued at \$64,160, in 1902. The above amount represents the purified sand containing from 85 to 99 per cent. monazite. This was obtained from about 1,600,000 pounds of crude sand as taken from the sluice-boxes, which is the material that goes through the magnetic separators. The price received for this crude sand by the individual miner varied from $2\frac{1}{2}$ to 6 cents per pound, according to the percentage of thoria that it contained. Cleveland County leads in the quantity and value of its production.

The quantity of zircon obtained in 1903 was 3,000 pounds, valued at \$570. This makes the total production of these minerals mined for use in the manufacture of various lamps amount to 865,000 pounds in quantity, valued at \$65,200. In the table below there is given the production and value of monazite mined in North Carolina from 1893 to 1903:

PRODUCTION OF MONAZITE IN NORTH CAROLINA FROM 1893 TO 1903.

YEAR.	POUNDS.	VALUE.
1893-----	130,000	\$ 7,600
1894-----	546,855	36,193
1895-----	1,573,000	137,150
1896-----	30,000	1,500
1897-----	44,000	1,980
1898-----	250,776	13,542
1899-----	350,000	20,000
1900-----	908,000	48,805
1901-----	748,736	59,262
1902-----	802,000	64,160
1903-----	773,000	58,694

BARYTES.

The principal use that is made of barytes is as a white pigment, and the first grade of this mineral, after being ground and made

ready for use, is known as "floated barytes." Whereas, formerly this mineral was considered as an adulterant, it is now recognized that barytes has excellent qualities of its own that make it of value as a pigment. Hence, at the present time, barytes is put on the market as a pigment and in competition with white lead and other white pigments. It has a pure white color, which is permanent, and it is unaffected by the weather or by gases that in some cases blacken white lead. It can also be used to advantage in combination with other white pigments, as white lead or zinc white. Of the total production of barytes, about four-fifths is used in the manufacture of white pigments. Other uses are in the manufacture of paper and rubber and also in the preparation of material that is used to coat canvas sacks in which hams are wrapped and made ready for market. Another use for this mineral that is increasing is in the manufacture of other barium compounds, principally the hydroxide.

Barium hydroxide was formerly prepared almost exclusively from the mineral witherite, barium carbonate; but on account of its rare occurrence in commercial quantity manufacturing chemists have been obliged to take up barytes as the raw material for manufacturing the hydroxide and other salts of barium. The principal use of barium hydroxide is in the beet sugar industry for the separation of the sugar left in the molasses. It is applicable in the same manner in the cane sugar industry. Another application that can probably be made of barium hydroxide which would cause it to be used in considerable quantity, is as a purifier of water used in some boilers. This would be especially applicable to acid waters. Still another use that has been considered is in the preparation of hides for tanning. As a pigment there are many ways in which barium white can be used, either as a preparation of the sulphate or as double salts.

PRODUCTION.

The production of crude barytes in North Carolina during 1903 was obtained principally from Madison County, with a small quantity from Gaston County, and amounted to 6,835 tons, valued at \$21,347. This is a decrease of 7,844 tons in quantity and of \$22,783 in value, as compared with the production of 1902, which was 14,679 tons, valued at \$44,130. The average value per ton of the 1903 produc-

tion was \$3.12½. In the following table there is given the production of barytes in North Carolina for the years 1901, 1902 and 1903:

PRODUCTION OF CRUDE BARYTES IN NORTH CAROLINA DURING
1901, 1902 AND 1903.

YEAR.	QUANTITY, SHORT TON.	VALUE.
1901-----	6,890	\$ 20,865
1902-----	14,679	44,130
1903-----	6,835	21,347

The quality of the North Carolina barytes is of the best, and as the demand for barytes is constantly increasing it was expected that the production of 1903 would have been at least equal to that of 1902. One thing that is against these deposits is their distance from the market, the crude barytes being shipped either to Lynchburg, Va., or Bristol, Tenn., or St. Louis, Mo. Thus the Virginia, Tennessee and Missouri deposits have an advantage in freight over those of North Carolina.

TALC AND PYROPHYLLITE.

PRODUCTION.

The demand for North Carolina talc, such as is found at the Hewitt mine in Swain County, is at the present time considerably greater than the supply. This particular deposit is unique in its occurrence and furnishes a talc which is much sought after for the manufacture of tailors' pencils, etc. The counties producing talc in 1903 were Swain, Cherokee, Madison and Jackson, given in the order of the importance of their production, while the pyrophyllite was obtained from Moore County. There is a small amount of the soapstone variety of talc quarried each year in the mountain counties, Alleghany, Yancey and Mitchell, which is used for fire-places, etc. The total production of these minerals in 1903 amounted to 5,331 tons, valued at \$76,984, which shows an increase of 92 tons in quantity, but a decrease of \$11,978 in value as compared with the production for 1902 of 5,239 tons, valued at \$88,962. The decrease in the value, with a slight increase in quantity, is due to the smaller

quantity of the higher-priced talc mined at the Hewitt mine. The largest amount of this production was obtained from Swain County, with smaller productions from Cherokee and Moore counties. The condition in which this production was marketed is shown in the following table:

PRODUCTION OF TALC AND PYROPHYLLITE IN NORTH CAROLINA
DURING 1901, 1902 AND 1903.

CONDITION IN WHICH MARKETED.	1901.		1902.		1903.	
	QUAN- TITY, SHORT TONS.	VALUE.	QUAN- TITY, SHORT TONS.	VALUE.	QUAN- TITY, SHORT TONS.	VALUE.
Ground talc for powders, etc. -----	2,864	\$ 29,505	3,381	\$ 31,628	3,762	\$ 37,606
Talc cut into pencils, gas tips, etc. -----	375	26,000	371	42,017	265	27,615
Talc sold crude -----	2,580	22,319	1,487	15,317	1,304	11,763
Soapstone cut into slabs for chimneys, etc. -----		150				
Total -----	5,819	\$ 77,974	5,239	\$ 88,962	5,331	\$ 76,984

In the table below there is given the value and quantity of talc and soapstone produced in North Carolina from 1898 to 1903, inclusive:

PRODUCTION OF TALC AND SOAPSTONE IN NORTH CAROLINA, 1898
TO 1903, INCLUSIVE.

YEAR.	QUANTITY.	VALUE.	YEAR.	QUANTITY.	VALUE.
	SHORT TONS.			SHORT TONS.	
1898 -----	1,695	\$ 27,320	1901 -----	5,819	\$ 77,974
1899 -----	1,817	31,880	1902 -----	5,239	88,962
1900 -----	4,522	75,308	1903 -----	5,331	76,984

GRAPHITE.

Although there is only a very small amount of graphite mined in North Carolina, yet on account of the numerous occurrences of this mineral throughout the State and of its high commercial value and demand, the subject is treated much more in detail than the actual

production of the mineral warrants. It is not improbable but that some of the localities where graphite is known to occur may develop into properties of commercial value, and this is especially true of some of those which at the present time are at some distance from railroad transportation, but which may, in the next few years, become available by reason of the railroads having penetrated into these districts.

Graphite is a mineral almost universally used, and there are but few households that are without it in one form or another. It is a mineral that was formerly but little understood, and even at the present time there is a vagueness regarding its value and uses and, in fact, regarding the character of the mineral itself. This is partially due to the different names that have been given to it in various localities in accordance with its uses, these names being graphite, black lead and plumbago. The mineral commonly occurs in embedded, foliated masses and also in granular, compact and micaceous masses, sometimes of a slaty structure and at other times earthy. Occasionally it is found in six-sided tabular crystals, but the faces of these are seldom distinct. In the foliated variety it has a perfect basal cleavage, the thin laminae when separated being flexible but not elastic. In color it varies from black to a dark steel-gray, and it has a metallic to sometimes dull and earthy luster and a greasy feel. In hardness it will vary from 1 to 2 and in specific gravity from 2.1 to 2.23, due to the amount of impurities. It closely resembles in physical properties the mineral molybdenite, a sulphide of molybdenum (MoS_2), which, however, gives a bluish-gray streak on paper, while the graphite gives gray-black. Chemically, however, the graphite is readily distinguished from the molybdenite, as its composition is carbon, although often impure from the presence of iron sesquioxide, clay, quartz, etc. The properties of graphite that make it especially valuable for the purposes for which it is used in the mechanic arts are softness, flexibility, low co-efficient of friction, conductivity, large adhesiveness, and exceedingly slow oxidation at high temperatures.

OCCURRENCES AND VARIETIES.

Graphite as a mineral is widely distributed in nature and occurs in gneisses, mica schists, crystalline limestones and pegmatitic dikes.

As an ore deposit, however, it is found in but few places, occurring in beds and embedded masses and laminae or scales in the rocks just mentioned. Schists are often impregnated with graphite to such an extent that they become graphitic schists, and have been observed extending over a number of miles of territory. Occasionally it is found in meteoric irons from a fraction up to 3 per cent. The world's supply of graphite is obtained from the following countries: Austria-Hungary, Ceylon, Germany, United States, Canada, Italy, Japan and Mexico, with, however, the larger amounts obtained from Austria-Hungary and Ceylon, these two countries together producing nearly six times as much as all the other countries combined.

There are three distinct varieties of graphite on the market—crystalline, amorphous, and artificial. These are used to some extent for the same purpose, but there are some uses to which each is especially applied. Of the two natural forms of graphite the crystalline is the more valuable, and is usually a purer grade of graphite, being worth about \$70 per ton, while the amorphous is only worth about \$15 per ton. The artificial graphite averages still higher in value, about \$92 per ton, this being due to the particular form in which some of it is produced.

Crystalline Graphite.—This variety can be used for all purposes for which graphite is required, but its chief uses are in the manufacture of refractory products, lubricants, electrotypes, and pencils, for which it is especially adapted on account of its purity. It has been estimated that of all the crystalline graphite consumed in the country, 55 per cent. was for crucibles, 15 per cent. for stove polish, 10 per cent. for foundry facings, 5 per cent. for paint, and 15 per cent. for all other purposes, including pencils, powder glazing, electrotyping, steam packing, and various other minor uses.* The coarser and purer form of the crystalline graphite is used for the manufacture of crucibles, pencils, lubricants, and electrotypes, and is known on the market as lump graphite and chip graphite, the former being more valuable. For the other purposes, as in the manufacture of stove polish, foundry facings, paints, etc., those grades of crystalline graphite known as dust and sweepings are used, the dust having the higher price.

*Mineral Resources U. S. for 1902; U. S. Geol. Survey, 1904, p. 975.

The bulk of the world's supply of crystalline graphite is obtained from the island of Ceylon. The refining of crystalline graphite is accomplished with but little difficulty, and the resultant product is usually very pure and free from any injurious compound. In some instances masses of the crystalline graphite are obtained that need no refining, and are ready for the crusher after simply being hand-cobbed.

Amorphous Graphite.—The occurrences of amorphous graphite are very much more abundant than those of the crystalline variety, but on account of the difficulty experienced in refining the crude ore, many of these deposits are not at the present time of commercial value. There are still others that are so isolated from railroad transportation facilities that it is impracticable to attempt to work them. Schists are often impregnated with graphite to such an extent that they become graphitic schists, and they have been observed extending over a number of miles of territory. Usually these schists contain also minute particles of quartz (silica), and although they may carry a very high percentage of graphite, it is impossible in many cases to obtain commercially pure and marketable graphite. This is due partly to the intricate manner in which the grains of quartz and graphite are intermingled, which makes it almost impossible to separate the quartz completely from the graphite, even by extremely fine crushing. Then again graphite and mica are found lying in parallel positions, so that it is almost impossible to separate the foliæ of one mineral from those of the other. In some instances the deposits of graphite are worked on a limited scale, and the production is shipped directly as mined for use for foundry facings and paints.

Such deposits of graphite occur very extensively in McDowell County, where there is a series of strata of graphitic schists in a country rock of mica schist and gneiss. These strata vary widely in percentage of graphite, some being quite lean and others richer. These graphitic schists can be traced for a distance of about 3 to 4 miles in a N. E.-S. W. direction from Brush Mountain on the west to Fork Mountain on the east. The deposit first becomes prominent near the Mill creek trestle of the Southern Railway. In width it is about 275 feet, with a very lean streak of the graphitic schist near the

center. The deposit occurs up and down five ridges, each of which rises to a height of 500 feet or more above the general level of this section of the country. Before attempting to work such deposits of graphite, they should be thoroughly tested as to whether or not they can be cleaned commercially. Deposits which may be very similar to each other, as far as one can judge from looking at them in the field or in the hand specimen, will differ very materially in respect to how they lend themselves to a cleaning process.

Another deposit similar to the above occurs three miles north of Raleigh, Wake County, and at these deposits graphite has been mined to some extent for the past four or five years.

The occurrence of graphite in pegmatitic dikes is well illustrated by the deposits in Alexander County about five miles from Taylorsville. The country rocks are schists and gneisses, and cutting through these are the pegmatitic dikes, varying from a few inches to 5 feet or more in thickness. The graphite, as it occurs in these pegmatitic dikes, is in the form of small particles and nodules from a fraction of an inch to 6 or more inches in diameter. As these pegmatitic dikes are more or less decomposed, the graphite in the upper portions of the dikes is more or less stained with iron oxide; but as the work on the deposit is continued deeper but little of the graphite was stained. The nodules of this mineral, when broken open, were found to be nearly pure, and on testing them no grit was observed. Nodules of the graphite occur quite abundantly on the eastern and northeastern slopes of Barrett's Mountain and for a distance of over 2 miles in a direction of a few degrees west of south. Only in a few places, however, in this belt has the graphite been located in place. What is apparently a similar occurrence of graphite has been found near Henrietta, Rutherford County, on the farm of Mr. Robert R. Simmons. The graphite has been found on the surface for over half a mile along the slopes of the ridge, and a number of pits have been sunk in an attempt to locate the graphite in place. The National Graphite Company continued the development of their graphite property in Yancey County about 7 miles east of Burnsville and will undoubtedly be shipping graphite late in the year of 1904.

There are large quantities of the amorphous graphite used in the manufacture of paints and for foundry facings. Some is also used in the manufacture of crucibles. The difficulty of purification of the amorphous graphite prevents its use for the manufacture of lubricants, the better quality of pencils, electrotypes, etc., except in a few instances, as in the case of some of that obtained from Bavaria and Mexico, and from one or two places in the United States.

Artificial Graphite.—Methods for the production of artificial graphite have been known for a great many years, but it is only within the last eight years that a method has been devised for manufacturing it commercially. The three principal methods by which artificial graphite has been made are: (1) By heating amorphous carbon to a very high temperature in the electric furnace. (2) By dissolving an excess of carbon in a molten metal at a high temperature; on allowing the metal to cool down the excess of carbon separates out as graphite. (3) By the dissociation of certain carbon compounds by means of metallic iron, or iron oxide, at high temperatures.

EXAMINATION OF GRAPHITE DEPOSITS.

On account of the constant increase in the demand for graphite, and of the fact that there is from six to ten times as much graphite imported into the United States as there is mined in this country, there is a great deal of interest aroused over the discovery of any large deposit of this mineral, especially of the crystalline variety. Any deposit of this mineral within reasonable distance of railroad transportation is worthy of investigation. There are, however, a number of points to be taken into consideration in estimating the value of a graphite deposit beside its location and cost of mining, which are: (1) Its variety, crystalline or amorphous. (2) The percentage of graphite in the ore. (3) The impurities that contaminate the ore, as mica, quartz, iron oxide, clay, etc. (4) Whether these impurities can be eliminated commercially. (5) The purpose for which the cleaned graphite can be used. Although it is important to know accurately the percentage of graphite that an ore carries, this is not of the first importance. It is very essential to determine whether or not the graphite ore can be so cleaned and refined as to produce a marketable product, and this should be deter-

mined before any large amount has been spent in the development of the deposit.

METHODS OF CLEANING.

The difficulties in purifying graphite have prevented the working of many deposits, even though they contain a considerable percentage of this mineral. The general methods employed for separating graphite from its impurities are based on the differences of specific gravity between it and its associated minerals. In these processes consideration is given to the difference in form between the particles of graphite and those of the gangue minerals. One of the minerals that is often difficult to separate from the graphite is mica, on account of its occurring in similar foliæ to that of the graphite, thus offering nearly the same surfaces to the solutions or blasts of air as the graphite. Briefly, the two principal methods used for purifying graphite have been described by Mr. W. F. Downs, E. M.,* as follows:

Treatment for purification by air.—This has long been a favorite field for experiment. The thin, flat scale of graphite offers more resistance to a current of air than an irregular fragment of gangue. The usual form of air jigs is further supplemented by settling chambers, dust-collectors, etc. These machines concentrate, but it is doubtful if they will make any pure graphite. Though frequently tried, they have never come into general use.

Treatment by water.—The amorphous grades are levigated on a large scale in Europe. This method frees the ore of coarse particles, but the earthy impurities carry over to the last settling vessel and much remains with the graphite. Even when the washing is carried to the extent that filter presses are used, clayey impurities still follow the graphite. The crystalline varieties occurring in the gneiss and schistose rocks are the most susceptible of treatment. These are crushed to a fineness sufficient to dissociate the graphite from the gangue, and first separated in buddles. This separation is of course incomplete, but when supplemented by sizing, regrinding, floating, etc., is carried to quite a high degree. These methods have attained great perfection in the United States.

For most of the purposes for which graphite is used it is not necessary to have it pure; but in the manufacture of electric goods, lubricants, and pencils, this is absolutely necessary. It is, however, the other uses that consume by far the most of the graphite that is mined.

*The Iron Age, May 3, 1900.

PRODUCTION.

The production of graphite during 1903 amounted to 50 tons, valued at \$248, as compared with a production of 830 tons, valued at \$4,300, in 1902. This is a decrease of 780 tons in quantity and of \$4,052 in value, and is due to the shutting down of the deposits at Graphiteville in McDowell County, which produced graphite in some quantity during 1902. The amount of graphite produced in the United States during 1903 was 18,860 tons, valued at \$225,554, of which only about 4,000 tons were used for the ordinary purposes of graphite. The balance of the production of 1903, which was sold at a price of about \$2 per ton, was used in the manufacture of fertilizers. Besides this natural production of graphite, there were 1,310 tons, valued at \$178,670, of artificial graphite produced. There was also imported into the United States 17,628 tons, valued at \$1,207,730. This makes a total of 22,758 tons, valued at \$1,568,589, after deducting the amount of graphite that was mined for fertilizer purposes. As is seen from the above, the amount of graphite imported for the manufacture of paints, lubricants, crucibles, slate pencils, etc., is about four times the amount produced in the United States, and thus emphasizes the benefit that would be derived by the United States if large deposits of commercial graphite could be found.

COAL.

PRODUCTION.

There are no extensive coal fields in North Carolina, and the only deposits that have thus far been worked on a commercial scale are those in Chatham County known as the Cumnock mines. This coal contains more or less sulphur, and it is very probable that its value could be very materially increased by washing. At the present time this coal is valued at about \$1.46 per ton f. o. b. mines, the price per ton having increased from \$1.07 in 1901 and \$1.24 in 1902. Similar coal measures occur in Stokes County near Walnut Cove, but no development work was done on these deposits during 1903, although it is expected that during the coming year they will be thoroughly prospected. The production of coal during 1903 in North Carolina amounted to 17,309 tons, valued at \$25,300, as compared with the

production of 23,000 tons, valued at \$24,500, in 1902. This is a decrease of 5,691 tons in quantity but an increase of \$800 in value. The increase in value per ton of the 1903 production over that of 1902 was 22 cents.

STONE.

There is a great variety of stone suitable for building purposes occurring in North Carolina, but at the present time only a few of the deposits have been thoroughly developed. The stones that are being utilized are granite, sandstone, marble and limestone; while the deposits of slate and serpentine which occur in quantity and of good quality have not as yet been developed to any great extent. There was a consolidation of a number of quarries during 1903, which included the large granite quarries of Thomas L. Woodroffe & Sons at Mt. Airy, Surry County. The name of the new corporation is the North Carolina Granite Corporation, whose home office is at Philadelphia, Pa.

Although the condition of the stone industry in the State at the close of 1903 was much better than at the close of 1902, yet the actual value of the production during 1903 was somewhat smaller than that of the previous year. In 1903 the value of the total production of building stones was \$360,322, as compared with \$366,727, the value of the production in 1902, this being a decrease of \$6,405.

In the following table there is given the value of the productions of the different stones quarried in 1902 and 1903:

PRODUCTION OF BUILDING STONE DURING 1902 AND 1903.

STONE.	1902.	1903.
	VALUE.	VALUE.
Granite-----	\$ 338,749	\$ 334,357
Sandstone-----	4,825	600
Marble and Limestone-----	23,153	25,365
Total-----	\$ 366,727	\$ 360,322

During the year 1903 investigations were carried on in the field relating to the occurrences of building stones in North Carolina, and the results of this work will appear shortly as Volume 3 of the

North Carolina Geological Survey. This report takes up in detail a description of the occurrences of the various building stones, their economic value and chemical and mineralogical composition.

GRANITE.

Production.

The total value of all the granite produced in 1903 was \$334,357, which is a decrease of \$4,492, as compared with the value of the production for 1901 of \$338,749. This production does not begin to represent what the granite industry of the State should attain when the quality as well as the quantity of the various varieties of granite are considered. Many of the quarries are very well located for railroad transportation and the occurrences of the stone are such that they can be quarried the most economically. The number of operators engaged in quarrying granite during 1903 was 24, who worked at 26 different localities in the following 12 counties: Surry, Rowan, Buncombe, Catawba, Henderson, McDowell, Orange, Polk, Rockingham, Vance, Warren, and Gaston, given in the order of the importance of their productions. Rowan County, which had the largest number of operators (10), was only second in the value of its production. In 1902 Rowan County, with 12 operators, was first in the value of the production. Gaston County, with 2 operators, was lowest in the value of its production, as it was also in 1902, when there were 5 producers. Surry County, in which are located the celebrated Mt. Airy quarries, produced the greatest value of granite. A little over one-third of the granite produced in the State during 1903 was used for building and monumental purposes, which is a decrease of \$40,153, as compared with the value of the granite used for the same purposes in 1902. There was a considerable increase in the value of the granite used for road-making and railroad ballast, the total value of the granite used for these purposes being \$102,524, an increase of \$24,765, as compared with \$77,759, the value of the production used for these same purposes in 1902. In the table below are given the different purposes for which the granite quarried in 1901, 1902 and 1903 was used.

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1901,
1902 AND 1903.

USES.	1901.	1902.	1903.
Building and monumental purposes	\$ 108,574	\$ 167,639	\$ 127,486
Paving blocks	10,662	6,986	30,780
Curbing and flagging	56,245	82,615	68,099
Crushed stone for road-making, railroad ballast, etc.	89,425	77,759	102,524
Other purposes		3,750	5,468
Total value	\$ 264,906	\$ 338,749	\$ 334,357

SANDSTONE.

Production.

Although there are good deposits of sandstone occurring in Anson, Moore, Chatham, Durham and Wake counties, this industry has always been small in North Carolina. In 1903 the production of sandstone had decreased to a value of but \$600, all of which was used for building purposes. This is a decrease of \$4,225, as compared with the value of the production of 1902, which was \$4,825, which in turn was a decrease of \$6,857, as compared with the production of 1901, which was valued at \$11,682.

MARBLE AND OTHER FORMS OF LIMESTONE.

Besides the interest in the marble and limestone deposits in North Carolina to be utilized for building purposes, considerable interest has been shown during the past year regarding these deposits as to the possibility of utilizing them in the manufacture of Portland cement. A number of inquiries have been received from parties outside the State for suitably located deposits of limestone with adjoining clay deposits or of marl deposits which occurred in sufficient quantity to warrant the establishment of a Portland cement manufacturing plant. During the past ten years a very great advance has been made in the utilization of cement in construction work, and this use has not only greatly increased the demand for Portland cement, but also the demand for deposits of the crude materials that are suitable for its manufacture. For this reason attention is called to the various de-

posits of limestone, marble, shale rock, marl, etc., that are known to occur in the State, with the idea that these deposits may be more thoroughly prospected and developed to prove their extent and the possibility of their utilization for the manufacture of Portland cement. It may also stimulate prospecting of new localities where there is a possibility of locating suitable deposits for this purpose.

The limestone deposits of the State should also be more thoroughly utilized for the burning of lime than they are at the present time, for by far the larger proportion of the lime used in North Carolina is imported from other States, principally from Tennessee and Virginia. The manufacture of lime from North Carolina limestones offers a promising field of investment, as the demand for lime is sure to keep pace with the increase in building and construction work; and there should be a good market for all that would be manufactured in the State. The occurrences of limestone in North Carolina are somewhat varied and widely separated in respect to locality. The deposits occurring in the southeastern counties are more or less admixed with clay and resemble marl. In other sections of these same counties it occurs in the form of a shell rock, such as the deposits that occur on the Northeast Cape Fear, Trent, and other rivers. In still other places it is to be found of a more compact nature, and forming fine-grained limestone rock which, however, has scattered through it here and there fossil shells which are more or less distinct in outline. This limestone rock often grades into a typical shell rock. These shell limestones are found in nearly horizontal beds in the coastal plain formation and are being used to some extent for building purposes, for road, and for harbor improvements. It is easily quarried and hardens sufficiently on exposure to the air to be very serviceable and makes a durable stone for rough, massive work.

The shell rock which occurs on the Northeast Cape Fear river opposite Rocky Point, Pender County, was employed about 14 years ago quite extensively for harbor improvements about Wilmington. This rock is overlain by 1 to 5 feet of soil and marl. Another use that has been made of this particular shell rock is in burning it to lime for agricultural purposes. It contains in certain portions of the rock small nodules of phosphate of lime. To the south of Rocky Point, at Castle Hayne, New Hanover County, there is a similar occurrence of

shell rock. The marls overlying these rocks, as well as the shell rocks themselves, have been, during the past year, investigated as to their value in the manufacture of Portland cement.

The shell rock that occurs on Trent river in Craven County is somewhat open in texture and has been used locally for rough building purposes and finished walls. The rock is composed of medium to large sized shells with an admixture of sand, the whole being cemented together with a carbonate of lime. This shell rock forms a durable building material and it can be easily quarried and brought to New Bern on flat-boats.

In the vicinity of Raleigh, Wake County, the limestone has been quarried to some extent, principally for burning to lime. These deposits are worthy of more thorough development and investigation.

In the piedmont counties there are several localities that contain limited deposits of a semi-crystalline limestone, notably those near Germantown, which is along the limestone belt that passes through Catawba, Lincoln, and Gaston counties. The deposits to the south of Bessemer City, Gaston County, offer possibilities of some promise as a suitable location for the manufacture of lime. In the western counties limestone is found in considerable quantities in Henderson, Transylvania, and Madison counties. The limestone in these counties has been utilized to some extent for burning to lime, but it has never been undertaken on a commercial scale, although the limestone makes a good quality of lime of a good white color. In the southern part of Transylvania County, the limestone becomes more siliceous and makes but an impure lime. In Henderson County the principal limestone beds lie about 7 to 10 miles west of Hendersonville in the vicinity of Boilston. In Madison County, limestone of fair quality is found in the vicinity of Hot Springs.

Extensive deposits of marble are found in Swain and Cherokee counties, and in the latter the deposits have been quite extensively developed by the National Marble Company of Murphy, North Carolina. They have taken out a very good quality of a blue-black and blue and white marble which makes a very handsome decorative and monumental stone. It can be obtained in large blocks for columns for building purposes and for shafts for monumental purposes. Its color is very good and this stone should find a ready market. White

and pink marble also occur to some extent in this same belt. In Swain County, on the property of Mr. Frank H. Hewitt, of Asheville, N. C., there is a large deposit of marble which is suitably located for quarrying and for railroad transportation. In McDowell County, about 10 miles north of Marion, there is a dolomitic marble which, while usually of a white color, is occasionally distinctly blue. Portions of this stone are well suited for building or ornamental purposes. Nearly all of these marbles would burn to an excellent lime, and, as nearly all the lime used in North Carolina is imported, the waste product obtained in quarrying could be utilized for this purpose and probably with very good financial results.

Production.

There was a production of marble from the Cherokee County deposits by the National Marble Company, which was used for building and monumental purposes, and judging from the work that is being done by this company and the quality of the marble that they are putting on the market, this is but the beginning of an industry that will become of some considerable importance in North Carolina.

The total production of marble and other forms of limestone in North Carolina during 1903 was valued at \$25,365, which is an increase of \$2,212 as compared with the production for 1902, which was valued at \$23,153. The larger proportion of the production was used for road-building and curbing. This production was obtained from Cherokee, New Hanover, and Pender counties, there being no production from Henderson County, which was one of the producers in 1902.

SLATE.

Slate of good quality is known to occur in the vicinity of Egypt, Pittsboro and Goldston, Chatham County, and near Albemarle, Stanly County. It has also been found in Durham and Alamance counties, but its actual value has not yet been determined. Near Mt. Gilead, Montgomery County, a slate quarry is being developed by Mr. J. J. Dun. The deposit, however, is 7 miles from the railroad.

CLAY.

There was a decided increase in the value of the production of clay products, including kaolin, in 1903 over the value of the production of 1902. The value of the 1903 production was \$942,458 as compared with \$908,105 during the previous year, being an increase of \$34,353. The value of the clay products, with the exception of kaolin, in 1903 was \$866,458, which is an increase of \$66,458 as compared with the value of the production of \$800,000 in 1902. This shows a decided increase in the clay industry, but it does not begin to represent the value of what the clay industry could and should be in North Carolina. There should be a much larger increase in the production of clay products, as there are good deposits of clay scattered throughout the State suitable for the manufacture of building brick of good quality that would stand transportation; for decorative brick; and for the manufacture of earthenware, sewer-pipe, terra-cotta, etc. At the present time a large proportion of the better grade of brick used in North Carolina is imported, and this is also true of a great deal of the earthenware, sewer-pipe, terra-cotta, etc.

KAOLIN OR CHINA-CLAY.

Kaolin deposits are known to occur in Jackson, Macon, Swain, and Buncombe counties. The best quality of kaolin, however, is that obtained from Jackson County, and that county has produced by far the largest quantity of any county in the State.

The American Land and Development Company are developing a deposit of kaolin near Barber's Creek Station, Jackson County, N. C., which is on the Asheville and Murphy branch of the Southern Railway. The deposit has been developed by a series of cross-cuts, pits and shafts which indicate that the clay occurs in considerable quantity and it is of good quality. This clay has been analyzed by Mr. F. F. Hunt, of 77 Pine Street, New York City, with the following results:

ANALYSIS OF KAOLIN FROM BARBER CREEK, JACKSON COUNTY.

	PER CENT.
Silica -----	44.66
Alumina -----	39.90
Iron -----	Trace
Alkalies -----	.68
Moisture -----	14.28
Total -----	99.52

In commenting on a sample of this clay sent to the American Encaustic Tiling Company, of Zanesville, Ohio, their superintendent, Mr. George A. Stanbery, made the following statement:

From the small sample sent us, we took 3 pounds of the clay and heaped it up, passing it through a No. 12 lawn. Twenty-five and one-half ounces of the clay went through the lawn and 22½ ounces refused to go through, which represents the waste. From the appearance of the sample, it looks as if the clay was very good. It shows white.

A fine clay that would furnish large quantities and of the same quality as the small sample sent would be valuable not only in our business, but to the white-ware potters. This clay is similar to that mined by the Harris Clay Company, which is the finest kaolin obtained in the United States.

There are a number of localities in the mountainous sections of North Carolina where kaolin occurs in small quantity, but as the feldspar from which the kaolin has been derived has been decomposed and altered to but a slight depth, these deposits of kaolin are soon worked out and the partially decomposed feldspar is encountered, which does not have the kaolin properties. Occasionally portions of the pegmatitic dike will be decomposed to a much greater depth than other portions and the kaolin will occur in bunches or pockets.

Nearly all of the kaolin that is mined in the State is shipped to the potteries at Trenton, N. J., or East Liverpool, Ohio, where it is utilized for those purposes which require the finest grade of clay. It is used in the manufacture of tiling; for the better grades of porcelain, and for the enamelling of brick. All those materials and others, such as electric porcelain insulators, etc., are imported into the State and sometimes have been made of the clay that has been exported. There should be a profitable investment in the utilization of these kaolins and similar clays for the manufacture of electric

porcelain insulator goods and pottery, all of which are now being imported into the State. In many sections we have the clay, the quartz and the feldspar required for the manufacture of these various clay products; and also good water-power that could be utilized in manufacturing them.

Production.

In 1903 all of the production of kaolin in the State was from Jackson County. Swain and Buncombe, which reported small productions in 1902, made none in 1903. The total quantity of kaolin mined in 1903 was 8,605 tons, valued at \$76,000, which is a decrease of 4,717 tons in quantity and of \$32,105 in value as compared with the production in 1902 of 13,322 tons, valued at \$108,105. The average value per ton of the 1903 production was \$8.83, which is an increase of 72 cents per ton as compared with the average value of \$8.11 per ton of the 1902 production.

POTTERY-CLAY.

Production.

There was a slight falling off in the value of the production of pottery in North Carolina during 1903, and the total value of this production of red earthenware and stoneware was only \$14,312, which is a decrease of \$200 as compared with \$14,512, the value of the production of 1902. There were 23 pottery manufacturers who aided in this production, and these were located in the following 8 counties, given in the order of the importance of their productions: Lincoln, Catawba, Buncombe, Chatham, Randolph, Wilkes, Union, and Jackson. In 1902 there were 28 pottery manufacturers located in the same 8 counties. There was no decorative ware reported as having been made in 1903. Of the 1903 production, \$612 was the value of the red earthenware, and \$13,700 of the stoneware. With improved methods and by exercising more care in the manufacture, and by using better material for glazing the ware, North Carolina potters would be able to put a far better grade of pottery on the market with but little or no more expense, and this would sell at a considerably increased price. The values of the different grades of pottery produced in the various counties during 1901, 1902 and 1903 are given in the following table:

VALUE OF THE POTTERY PRODUCTS OF NORTH CAROLINA
BY COUNTIES IN 1901, 1902 AND 1903.

COUNTY.	1901.				1902.			1903.		
	EARTHEN- WARE.	STONE- WARE.	DECOR- ATIVE WARE, ETC.	TOTAL.	EARTHEN- WARE.	STONE- WARE.	TOTAL.	EARTHEN- WARE.	STONE- WARE.	TOTAL.
Buncombe-----	\$ 280	\$ 3,100	\$-----	\$ 3,320	\$ 150	\$ 1,850	\$ 2,010	\$ 60	\$ 2,200	\$ 2,260
Catawba-----		2,540		2,540	55	4,410	4,465		3,155	3,155
Chatham-----		2,700		2,700		2,000	2,000		2,000	2,000
Cumberland-----	60			60						
Johnston-----	525	1,700		2,225	40	525	565	80	255	335
Lincoln-----	2,500	2,000	25	4,525	25	2,900	2,925	100	3,270	3,370
Randolph-----	860	3,173	200	4,233	28	769	797	222	1,320	1,542
Union-----	325	1,040	27	1,392	300	300	600	100	400	500
Warren-----			300	300						
Wilkes-----		1,200		1,200	50	1,100	1,150	50	1,100	1,150
Total-----	\$ 4,490	\$ 17,453	\$ 542	\$22,495	\$ 658	\$13,854	\$14,512	\$ 612	\$13,700	\$ 14,312

FIRE-CLAY AND PIPE-CLAY.

Production.

There was a very decided increase in the production of fire-clay and pipe-clay products during 1903, and this increase was for the most part in connection with the manufacture of tiling and the better grades of sewer-pipe. The total value of all fire-clay and pipe-clay products reported in 1903 was \$107,114, this including fire-brick, fire-clay sold crude, sewer-pipe, tile, etc. This is an increase of \$33,078 in value as compared with \$74,036, the value of the production of 1902. This in turn was an increase of \$16,576 in value as compared with the value of the production of 1901, which was \$56,395. This continued increase in the production of these clay products illustrates what can be accomplished in the manufacture of the better grade of clay products, but this production should increase many times more, as the demand for these products in the State fully warrants this.

Of the 1903 production, \$5,250 was the value of 407,500 fire-brick, which is an increase of 322,500 fire-brick in quantity and of \$4,047 in value as compared with the production of 1902 of 85,000 fire-brick, valued at \$1,203. There was also a small amount of crude fire-clay sold in 1903, amounting to 231 tons, valued at \$875. In 1902 the value of the crude fire-clay sold was \$215.

The most noticeable increase in the production of these clay products was sewer-pipe, tile, etc., whose value in 1903 was \$107,114, which is an increase of \$34,496 as compared with \$72,618, the value of the production in 1902. This in turn was an increase of \$16,873 as compared with \$55,745, the value of the production in 1901. Although there has been this decided increase since 1901, the production does not begin to represent the increase that there should be in this industry in North Carolina.

BRICK-CLAY.

There are clay deposits suitable for the manufacture of brick occurring in the greater number of counties throughout North Carolina, and in a number of these the clay is of such quality that it is capable of being used in the manufacture of pressed brick, front brick or decorative brick, which should find a ready market throughout the State and also in adjoining States. In order, however, to utilize these clays for this purpose, more attention will have to be given to details in the manufacturing of the brick than is being done at the present time in order to put a better made brick on the market, and one which is not only more attractive in appearance, but also capable of standing transportation and rough handling. While there is but little margin of profit in the manufacture of the cheaper grades of brick, there is a good margin of profit in the manufacture of the better quality of bricks, such as pressed brick and decorative brick. Contractors throughout the State are constantly attempting to utilize for the manufacture of brick clays found in the vicinity of where they are erecting buildings; and often the bricks that are made will hardly hold together long enough to be laid during the course of the construction of the building. In a number of instances brick that were being used in the construction of public as well as private buildings have been examined, which, if there had been any inspector of buildings, would have been thrown out as totally unfit for any use in construction. It is not always the fault of the clay that such poor brick are made, but due to the poor methods used in the manufacture of the brick and often to the unskilled labor employed.

Production.

During 1903 brick were manufactured in 62 counties, which is 5 less than in 1902. Seven counties, Franklin, Granville, Hertford, Person, Vance, Warren, and Yadkin, which reported a production of brick during 1902, reported none in 1903, while Ashe and Jackson counties, which made no production in 1902, were producers of brick in 1903. The total number of all kinds of brick, except fire-brick, made during 1903 amount to 138,088,900, valued at \$745,032, this being an average value of \$5.39 per thousand. This production is an increase of 4,537,200 brick in quantity and of \$33,580 in value as compared with the production of 133,551,700 brick, valued at \$711,452 in 1902.

Of the 1903 production there were 136,822,900 common brick, valued at \$731,802, which is an increase of 5,211,200 brick in quantity and of \$36,975 in value as compared with the production of 131,611,700 common brick, valued at \$694,827, in 1902. The number of pressed brick manufactured in 1903 were 766,000, valued at \$8,230, and of vitrified brick, 500,000, valued at \$5,000. In the table below are given the quantity and value of the common, pressed and vitrified brick produced in 1901, 1902 and 1903:

PRODUCTION OF COMMON, PRESSED, VITRIFIED AND FIRE-BRICK
IN 1901, 1902 AND 1903.

CHARACTER.	1901.		1902.		1903.	
	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.
Common brick-----	134,441,570	\$697,861	131,618,700	\$694,827	136,822,900	\$ 731,802
Pressed brick-----	1,095,000	10,220	1,833,000	10,625	766,000	8,230
Vitrified brick-----	180,000	1,650	600,000	6,000	500,000	5,000
Fire-brick-----	55,000	550	120,000	1,203	407,500	5,250
Total-----	135,771,570	\$710,281	134,171,700	\$712,655	138,496,400	\$ 750,282

There was also a slight increase in the average value per thousand of the 1903 production as compared with the average value of \$5.33 per thousand of the 1902 production, this being an increase of 6 cents per thousand. As compared with the 1901 production the increase in the average value per thousand is 16 cents, the average

price received in 1901 being \$5.23 per thousand. The number of manufacturers engaged in making brick during 1903 was 171, which is 24 less than the number (195) engaged in this business in 1902. This in turn was 36 less than the number (231) in 1901. The lowest value per thousand reported as having been received for brick during 1903 was \$3.50 and the highest \$10, this latter value being for vitrified brick, as compared with \$3.75 and \$10, which were the lowest and highest prices received respectively for brick during 1902. The highest price reported as having been received for common brick was \$8 per thousand, the same as reported in 1902. This value was received for a small production made in Washington County. In the following tables are given the total number and value of the different varieties of brick, including fire-brick, manufactured in 1903 and 1902 by counties:

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA DURING 1903 BY COUNTIES.

COUNTY.	COMMON BRICK.	VALUE.	PRESSED BRICK.	VALUE.	VITRIFIED AND FIRE- BRICK.	VALUE.
Alamance -----	2,750,000	\$ 15,250	-----	\$-----	-----	\$-----
Anson -----	1,000,000	5,500	-----	-----	-----	-----
Ashe -----	300,000	1,500	-----	-----	-----	-----
Beaufort -----	1,323,000	8,200	-----	-----	-----	-----
Bertie -----	4,600,000	21,000	-----	-----	-----	-----
Bladen -----	200,000	1,100	-----	-----	-----	-----
Buncombe -----	4,305,900	22,686	150,000	2,250	365,500*	5,100
Burke -----	400,000	1,600	-----	-----	-----	-----
Cabarrus -----	5,010,000	25,055	100,000	1,000	-----	-----
Caldwell -----	1,500,000	5,250	-----	-----	-----	-----
Carteret -----	150,000	900	-----	-----	-----	-----
Catawba -----	1,920,000	9,680	-----	-----	-----	-----
Chatham -----	-----	-----	-----	-----	2,000†	20
Chowan -----	1,000,000	7,000	-----	-----	-----	-----
Cleveland -----	975,000	5,320	200,000	2,000	-----	-----
Columbus -----	2,000,000	10,000	-----	-----	-----	-----
Craven -----	6,000,000	47,750	-----	-----	-----	-----
Cumberland -----	1,750,000	9,500	-----	-----	-----	-----
Davidson -----	500,000	2,500	-----	-----	-----	-----
Duplin -----	50,000	278	-----	-----	-----	-----
Durham -----	6,710,000	36,210	-----	-----	-----	-----
Edgecombe -----	5,450,000	32,700	-----	-----	-----	-----
Forsyth -----	8,505,000	44,625	150,000	1,500	-----	-----
Gaston -----	2,670,000	14,350	-----	-----	-----	-----
Gates -----	105,000	375	-----	-----	-----	-----
Greene -----	635,000	4,445	-----	-----	-----	-----

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA DURING 1903 BY COUNTIES—CONTINUED.

COUNTY.	COMMON BRICK.	VALUE.	PRESSED BRICK.	VALUE.	VITRIFIED AND FIRE- BRICK.	VALUE.
Guilford -----	8,188,000	\$ 44,817		\$		\$
Halifax -----	3,400,000	19,500	70,000	600		
Harnett -----	2,500,000	10,800				
Haywood -----	700,000	3,990				
Henderson -----	1,000,000	5,000			500,000*	5,000
Iredell -----	3,200,000	15,900				
Jackson -----	70,000	420				
Johnston -----	1,730,000	10,350				
Lenoir -----	1,000,000	6,500				
Lincoln -----	830,000	4,150				
McDowell -----	2,900,000	14,500				
Martin -----	8,000	48				
Mecklenburg -----	2,300,000	14,000				
Montgomery -----	282,000	1,403				
Moore -----	2,682,000	13,687				
Nash -----	1,000,000	5,500				
New Hanover -----	2,750,000	16,500				
Orange -----	1,000,000	4,950			30,000†	30
Pasquotank -----	1,800,000	10,800				
Pitt -----	1,240,000	7,458				
Randolph -----	780,000	3,742			10,000†	100
Robeson -----	352,000	2,103	14,000	124		
Rockingham -----	3,216,000	18,860				
Rowan -----	2,500,000	13,500				
Rutherford -----	650,000	3,340				
Sampson -----	50,000	250				
Scotland -----	600,000	3,300				
Stanly -----	300,000	1,200				
Surry -----	1,210,000	5,755	50,000	500		
Transylvania -----	95,000	500				
Union -----	3,437,000	15,555				
Wake -----	5,166,000	26,095				
Washington -----	30,000	240				
Wayne -----	9,150,000	51,075				
Wilkes -----	1,598,000	7,990	32,000	256		
Wilson -----	6,300,000	35,250				
Total -----	136,822,900	\$ 731,802	766,000	\$ 8,230	907,500	\$ 10,250

*Vitrified brick.

†Fire-brick.

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA
DURING 1902.

COUNTY.	COMMON BRICK.	VALUE.	PRESSED BRICK.	VALUE.	VITRIFIED BRICK.	VALUE.
Alamance -----	5,220,000	\$ 24,075		\$ -----		\$ -----
Anson -----	600,000	3,500				
Beaufort -----	1,440,000	9,000				
Bertie -----	3,616,000	18,635	500,000	4,000		
Bladen -----	400,000	2,000				
Buncombe -----	4,750,000	23,978				
Burke -----	1,700,000	6,800				
Cabarrus -----	85,000	425				
Caldwell -----	1,260,000	5,720				
Carteret -----	990,000	500				
Catawba -----	477,000	2,072				
Chatham -----	100,000	500				
Chowan -----	1,000,000	7,000				
Cleveland -----	1,258,000	6,148				
Columbus -----	1,200,000	6,000				
Craven -----	4,500,000	22,500				
Cumberland -----	3,000,000	15,000				
Davidson -----	2,320,000	13,000				
Duplin -----	263,700	1,458				
Durham -----	5,050,000	25,825				
Edgecombe -----	4,050,000	23,500				
Forsyth -----	3,442,000	15,423				
Franklin -----	200,000	1,400				
Gaston -----	1,725,000	7,845				
Gates -----	105,000	430				
Granville -----	800,000	6,000				
Greene -----	910,000	5,478				
Guilford -----	8,802,000	44,160	240,000	1,900		
Halifax -----	4,050,000	23,500	175,000	1,575		
Harnett -----	2,400,000	9,900				
Haywood -----	400,000	2,200				
Henderson -----	1,000,000	6,000	30,000	450	600,000	6,000
Hertford -----	140,000	880	140,000	880		
Iredell -----	1,500,000	8,050				
Johnson -----	570,000	3,600				
Lenoir -----	3,000,000	18,500				
Lincoln -----	300,000	1,500				
McDowell -----	900,000	5,300				
Martin -----	19,000	105				
Mecklenburg -----	2,765,000	14,418				
Montgomery -----	300,000	1,500	80,000	650		
Moore -----	1,650,000	7,200				
Nash -----	2,000,000	11,000				
New Hanover -----	1,000,000	5,500				
Orange -----	370,000	1,630				
Pasquotank -----	1,650,000	9,575				
Person -----	6,000,000	36,000				
Pitt -----	1,728,000	11,122				
Randolph -----	1,590,000	7,550				
Robeson -----	625,000	3,780				
Rockingham -----	4,447,000	22,267				
Rowan -----	1,800,000	10,500				
Rutherford -----	200,000	850				
Sampson -----	100,000	500				

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA
DURING 1902—CONTINUED.

COUNTY.	COMMON BRICK.	VALUE.	PRESSED BRICK.	VALUE.	VITRIFIED BRICK.	VALUE.
Scotland -----	500,000	\$ 2,500	-----	\$-----	-----	\$-----
Stanly -----	500,000	2,570	-----	-----	-----	-----
Surry -----	1,115,000	5,955	-----	-----	-----	-----
Transylvania -----	600,000	3,000	-----	-----	-----	-----
Union -----	900,000	4,685	-----	-----	-----	-----
Vance -----	100,000	700	-----	-----	-----	-----
Wake -----	5,215,000	26,573	50,000	450	-----	-----
Warren -----	100,000	500	-----	-----	-----	-----
Washington -----	160,000	1,100	-----	-----	-----	-----
Wayne -----	13,850,000	70,350	-----	-----	-----	-----
Wilkes -----	1,325,000	6,380	115,000	690	-----	-----
Wilson -----	8,333,000	48,950	-----	-----	-----	-----
Yadkin -----	53,000	265	33,000	30	-----	-----
Total -----	131,618,700	\$694,827	1,333,000	\$ 10,625	600,000	\$ 6,000

As is seen from the above table of the production of brick in 1903, of the 97 counties in North Carolina only 62 reported any production of brick. The county to produce the largest number of brick in 1903 was Wayne, whose production was 9,150,000, valued at \$51,075. This county was also the largest producer in 1902, when its production amounted to 13,850,000, valued at \$70,350, this being 4,700,000 more than in 1903. Forsyth County was second in 1903, with a production of 8,655,000 brick, valued at \$46,125. Guilford County, which was second in 1902, with a production of 9,042,000, valued at \$46,060, was third in 1903, with a production of 8,188,000 brick, valued at \$44,817. The county producing the smallest number of common brick was Martin, which reported a production of only 8,000, valued at \$48. This county was also the smallest producer in 1902, when the production reported amounted to 19,000 brick, valued at \$105. There is given in the table below the quantity and value of all the clay products produced in North Carolina in 1901, 1902 and 1903. The above statistics regarding the clay production of the State does not, perhaps, represent the output in its entirety, for the reason that in a number of the mountain counties there are a few thousand brick occasionally made for local purposes, regarding which it is difficult or impossible to obtain any statistics.

VALUE OF CLAY PRODUCTIONS OF NORTH CAROLINA IN
1901, 1902 AND 1903.

	1901.		1902.		1903.	
	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.
Common brick-----	134,441,570	\$697,861	131,611,700	\$694,827	136,822,900	\$ 731,802
Pressed brick-----	1,095,000	10,220	1,233,000	10,625	766,000	8,230
Vitrified brick-----	180,000	1,650	600,000	6,000	500,000	5,000
Fire-brick-----	55,000	550		1,203	407,500	5,250
Earthenware-----		4,490		658		612
Stoneware-----		17,453		13,854		13,700
Decorated ware-----		552				
Sewer-pipe, tile, etc.		55,745		72,613		100,989
	TONS.		TONS.		TONS.	
Kaolin-----	15,575	119,172	13,322	108,105	8,605	76,000
Fire-clay-----		100		215	281	875
Total value-----		\$907,793		\$908,105		\$ 942,458

In the following table there is given the total mineral production of the State for the years 1900 to 1903, inclusive:

THE MINERAL PRODUCTION IN NORTH CAROLINA FOR THE YEARS
1900, 1901, 1902 AND 1903.

MINERAL.	VALUE.			
	1900.	1901.	1902.	1903.
Gold-----	\$ 46,653	\$ 60,411	\$ 93,650	\$ 113,604
Silver-----	15,986	34,024	30,212	16,907
Copper-----	41,600	76,900	212,553	67,037
Iron-----	42,000	4,997	52,771	78,540
Pyrite-----	14,625	32,000		
Garnet-----	18,000	43,000	10,040	12,250
Corundum-----	36,840	48,840		
Millstones-----			1,425	902
Mica { Sheet-----	65,200	79,849	81,653	86,300
{ Scrap-----	36,262	14,200	2,919	2,400
Quartz-----		7,500	11,250	36,827
Precious stones-----	12,020	24,245	5,300	1,525
Rare minerals-----			60	270
Monazite-----	48,805	59,262	64,160	58,694
Zircon-----			360	570
Barytes-----		22,615	44,130	21,347
Talc and pyrophyllite-----	42,000	77,974	88,962	76,984
Graphite-----		559	4,300	248
Coal-----	22,500	5,585	24,500	25,300
Stone-----	285,172	284,744	366,727	360,322
Kaolin-----	62,440	119,172	108,105	76,000
Clay products-----	815,975	788,618	800,000	866,458
Total value-----	\$1,604,078	\$1,779,109	\$2,003,077	\$ 1,902,485

As is seen from the above table, there was a slight falling off in the total value of \$1,902,485 of the mineral production for 1903 as compared with that of \$2,003,077 for 1902, this decrease amounting to \$100,592. There were 78 counties of the 97 in the State from which the mineral production of 1903 was obtained, and in the following table the value of the production for each county is given. The value of the clay products, with the exception of kaolin, which is included with the other minerals, is given separately from the rest of the mineral production.

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH CAROLINA IN 1902 AND 1903.

COUNTY.	1902.			1903.		
	MINERAL PRODUCTION, INCLUDING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.	MINERAL PRODUCTION, INCLUDING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.
Alamance	\$-----	\$24,075	\$ 24,075	\$-----	\$ 15,250	\$ 15,250
Alexander	200	-----	200	50	-----	50
Alleghany	-----	-----	-----	-----	-----	-----
Anson	-----	4,250	4,250	600	5,500	6,100
Ashe	-----	-----	-----	1,000	1,500	2,500
Beaufort	-----	9,500	9,500	-----	8,200	8,200
Bertie	-----	22,653	22,653	-----	21,300	21,300
Bladen	-----	2,018	2,018	-----	1,100	1,100
Brunswick	-----	-----	-----	-----	-----	-----
Buncombe	18,375	27,463	45,838	14,566	32,371	46,937
Burke	10,238	6,800	17,038	12,629	1,600	14,229
Cabarrus	10,650	425	11,076	3,323	26,055	29,378
Caldwell	19	5,720	5,739	42	5,250	5,292
Camden	-----	-----	-----	-----	-----	-----
Carteret	-----	500	500	-----	900	900
Caswell	-----	-----	-----	-----	-----	-----
Catawba	8,336	6,562	14,898	7,060	12,835	19,895
Chatham	24,630	2,500	27,130	27,523	2,000	29,523
Cherokee	21,952	-----	21,952	50,116	-----	50,116
Chowan	-----	7,000	7,000	-----	7,020	7,020
Clay	200	-----	200	297	-----	297
Cleveland	16,000	6,148	22,148	19,969	7,320	27,289
Columbus	-----	6,000	6,000	-----	10,000	10,000
Craven	-----	22,500	22,500	-----	47,750	47,750
Cumberland	19	15,000	15,019	-----	9,500	9,500
Currituck	-----	-----	-----	-----	-----	-----
Dare	-----	-----	-----	-----	-----	-----
Davidson	27,971	13,000	40,971	672	2,500	3,172
Davie	-----	-----	-----	-----	-----	-----
Duplin	-----	1,458	1,458	-----	278	278
Durham	-----	25,825	25,825	-----	36,210	36,210

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH
CAROLINA IN 1902 AND 1903—CONTINUED.*

COUNTY.	1902.			1903.		
	MINERAL PRO- DUCTION, INCLUD- ING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.	MINERAL PRO- DUCTION, INCLUD- ING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.
Edgecombe	\$ -----	\$ 23,500	\$ 23,500	\$ -----	\$ 32,700	\$ 32,700
Forsyth	3,057	15,623	18,680	-----	46,401	46,401
Franklin	632	1,400	2,032	165	-----	165
Gaston	8,874	7,845	16,719	1,112	14,350	15,462
Gates	-----	430	430	-----	375	375
Graham	-----	-----	-----	-----	-----	-----
Granville	3,996	6,000	9,996	5,477	-----	5,477
Greene	-----	5,478	5,478	-----	4,445	4,445
Guilford	966	117,560	118,526	3,966	144,817	148,783
Halifax	1,356	25,075	26,431	426	20,100	20,526
Harnett	-----	9,900	9,900	-----	10,800	10,800
Haywood	20,850	2,200	23,050	18,560	3,990	22,550
Henderson	16,201	12,450	28,651	17,589	10,800	28,389
Hertford	-----	1,760	1,760	-----	-----	-----
Hyde	-----	-----	-----	-----	-----	-----
Iredell	434	8,050	8,484	160	15,900	16,060
Jackson	119,905	-----	119,905	94,646	420	95,066
Johnston	475	4,165	4,640	15,000	10,685	25,685
Jones	-----	-----	-----	-----	-----	-----
Lenoir	-----	18,500	18,500	-----	6,500	6,500
Lincoln	9,845	4,425	14,270	15,256	7,520	22,776
McDowell	42,715	5,300	48,015	34,690	14,500	49,190
Macon	6,344	-----	6,344	3,749	-----	3,749
Madison	42,630	-----	42,630	26,447	-----	26,447
Martin	-----	105	105	-----	48	48
Mecklenburg	21,300	14,418	35,718	8,682	14,000	22,682
Mitchell	79,319	-----	79,319	93,127	-----	93,127
Montgomery	39,173	2,150	41,323	49,513	1,403	50,916
Moore	13,937	7,200	21,137	7,769	13,687	21,456
Nash	299	11,000	11,299	142	5,500	5,642
New Hanover	21,063	5,500	26,563	20,400	16,500	36,900
Northampton	-----	-----	-----	-----	-----	-----
Onslow	-----	-----	-----	-----	-----	-----
Orange	5,462	1,648	7,110	27,781	4,980	32,761
Pamlico	-----	-----	-----	-----	-----	-----
Pasquotank	-----	9,575	9,575	-----	10,800	10,800
Pender	470	-----	470	600	-----	600
Perquimans	-----	-----	-----	-----	-----	-----
Person	157,010	36,000	193,010	71,316	-----	71,316
Pitt	-----	11,122	11,122	-----	7,458	7,458
Polk	1,339	-----	1,339	7,507	-----	7,507
Randolph	1,076	8,547	9,623	403	5,797	6,200
Richmond	-----	-----	-----	-----	-----	-----
Robeson	-----	3,780	3,780	-----	2,227	2,227
Rockingham	-----	22,267	22,267	10,200	18,860	29,060
Rowan	187,777	10,500	198,277	112,573	13,500	125,073
Rutherford	18,269	850	19,119	12,344	3,340	15,680
Sampson	-----	500	500	-----	250	250
Scotland	-----	2,500	2,500	-----	3,300	3,300

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH
*CAROLINA IN 1902 AND 1903—CONTINUED.

COUNTY.	1902.			1903.		
	MINERAL PRO- DUCTION, INCLUDING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.	MINERAL PRO- DUCTION, INCLUDING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.
Stanly -----	\$ 867	\$ 2,570	\$ 3,437	\$ 24,640	\$ 1,200	\$ 25,840
Stokes -----	1,000	-----	1,000	7,740	-----	7,740
Surry -----	116,965	-----	116,965	111,462	6,255	117,717
Swain -----	74,187	-----	74,187	53,150	-----	53,150
Transylvania-----	780	3,100	3,880	516	500	1,016
Tyrrell -----	-----	-----	-----	-----	-----	-----
Union -----	754	5,285	6,039	3,198	16,055	19,253
Vance -----	17,554	700	18,254	\$14,750	-----	14,750
Wake -----	9,200	27,023	36,223	248	26,095	26,343
Warren -----	121	500	621	751	-----	751
Washington-----	-----	1,100	1,100	-----	240	240
Watauga -----	-----	-----	-----	-----	-----	-----
Wayne -----	-----	70,350	70,350	-----	51,075	51,075
Wilkes -----	-----	8,220	8,220	-----	9,396	9,396
Wilson -----	-----	48,950	48,950	-----	35,250	35,250
Yadkin -----	-----	295	295	-----	-----	-----
Yancey -----	22,159	-----	22,159	20,600	-----	20,600
Unknown -----	1,030	-----	1,030	1,525	-----	1,525
Total value-	\$1,203,077	\$800,000	\$2,003,077	\$866,458	\$1,036,027	\$ 1,902,485

Of the 78 counties reporting a mineral production for 1903, there were only 48 counties that reported anything besides clay products. There were 62 counties reporting a production of clay, of which 29 counties did not report any other mineral production. There were 14 counties reporting a mineral production, but none of clay products. The number of counties producing both clay and other mineral products was 34. There were 19 counties that did not report the production of any mineral whatever during 1903. The county reporting the greatest value for its mineral production, except clay products, was Rowan, the value being \$112,573. The county producing the greatest value of clay products was Guilford, the value being \$144,817. The county whose total mineral production was greatest in value in 1903 was Guilford, the value being \$148,783. Rowan County is second in the valuation with a production valued at \$125,073. The lowest value reported by any county was \$48, which was the value of the mineral production of Martin County.

PUBLICATIONS OF THE NORTH CAROLINA GEOLOGICAL SURVEY.

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Postage 10 cents.*
2. Building Stone in North Carolina, by Joseph A. Holmes, George P. Merrill and T. L. Watson. *In preparation.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Out of print.*
8. Water powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Postage 4 cents.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Postage 10 cents.*
11. Corundum and the Basic Magnesians Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Postage 4 cents.*
12. Drinking Water Supplies in North Carolina, by Joseph A. Holmes. *In preparation.*
13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Reis, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*
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15. Mineral Waters of North Carolina, by F. P. Venable. *In press.*
16. A List of Elevations in North Carolina, by J. A. Holmes and E. W. Myers. *In preparation.*
17. Historical Sketch of North Carolina Scientific and Economic Surveys; and Bibliography of North Carolina Geology, Mineralogy and Natural History, by J. A. Holmes and L. C. Glenn. *In preparation.*
18. Road Materials and Construction, by Joseph A. Holmes and William Cain. *In preparation.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglass B. Sterrett, 1904. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. The Loblolly Pine in Eastern North Carolina, by W. W. Ashe. *In preparation.*

ECONOMIC PAPERS.

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*
2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Tale and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*
4. The Mining Industry in North Carolina during 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*
5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*
6. The Mining Industry in North Carolina during 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*
7. Mining Industry in North Carolina during 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Postage 2 cents.*
8. The Mining Industry in North Carolina during 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

REPORTS.

Vol. 1. Corundum and the Peridotites in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis. *In press.*

Vol. 2. Fish and Fisheries in North Carolina, by H. M. Smith. *In preparation.*

Vol. 3. Building Stones of North Carolina, by G. P. Merrill, F. B. Laney and T. L. Watson. *In preparation.*

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THE NORTH CAROLINA GEOLOGICAL AND
ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST.

Economic Paper No. 11.

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1905

BY

JOSEPH HYDE PRATT, Ph.D.



RALEIGH

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1907

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LETTER OF TRANSMITTAL.

CHAPEL HILL, N. C., December 1, 1906.

To His Excellency, HON. ROBERT B. GLENN,
Governor of North Carolina.

SIR:—I herewith have the honor to submit for publication Economic Paper No. 11, a Report on the Mining Industry in North Carolina for the Year 1905. In order to satisfy certain inquiries that are being received regarding the mining laws of North Carolina, there is given at the end of this report a list of the mining laws as given in the Revisal of The Code for 1905.

Yours obediently,

JOSEPH HYDE PRATT,
State Geologist.

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MINING INDUSTRY IN NORTH CAROLINA DURING 1905.

By JOSEPH HYDE PRATT.

INTRODUCTION.

It is gratifying to note that during the year 1905 there was a decided increase in the production of those minerals which constitute North Carolina's chief mineral resources. Thus the productions of talc and soapstone, monazite, mica, building stones and clay products showed a very marked increase over the productions of 1904. In regard to building stones, the 1905 production was nearly twice that of the previous year and shows the remarkable growth of the building-stone industry in the State, due to systematic advertising and increased efficiency of quarrying methods. The Survey has coöperated with the producers of building stones and done all in its power to advance this industry in the State.

The production of clay products, which has constantly increased in value during the past five years, showed a decided gain in 1905, especially in value. Notwithstanding the large demand for brick and other clay products in the State and the increase in the value of these products, there is still a lack of enterprise on the part of most of the manufacturers of these in adopting new and up-to-date methods for working these clays. Thus they are only able to make the lowest grade of clay products, which are not able to command the high prices that are paid for a better quality of goods, the greater portion of which is now imported into North Carolina.

Of the two minerals, monazite and mica, North Carolina produces the greatest amounts of any State in the Union, and during 1905 it very largely increased its production of monazite as compared with that of 1904. The production of mica was only slightly increased over that of the previous year.

Of the heavy metals, such as gold, silver, and copper, North Carolina's production does not play a very important part at the present time in the total production of these mines in this country. Although

the increase in the value of the production of these metals in 1905 as compared with 1904 was not large, yet there has continued to be a large amount of systematic development work carried on which has resulted in the opening of ore bodies of economic importance which will undoubtedly be mined and their metal contents placed on the market in the near future. A systematic investigation has been made during the past summer of the gold and copper mines of the State, and a preliminary report of the results of these investigations will be published shortly as an Economic Paper of the Survey publications.

Another mineral product that has caused considerable interest to center in North Carolina is tin, which has been mined in Gaston and Lincoln counties. Although the actual value of these tin deposits is still problematic and their success dependent largely on efficient management, yet the scarcity of this metal makes the North Carolina deposits of extreme interest, and a number of them are worthy of development, as they do offer possible chances of profitable investment if properly and economically managed.

The mining and quarrying industries of the State, as a whole, are perhaps in the most prosperous and flourishing condition ever known in the history of the State, and this cannot help but mean still greater activity in mining and a larger investment in the mineral resources of the State.

During 1905 the total value of the mineral production of North Carolina* was \$2,439,381 as compared with \$1,946,273 in 1904, an increase of \$493,108. This increase is 25 per cent of the total production of 1904. The minerals and ores that have been mined in North Carolina during 1905 are given below in the order in which they are discussed in this report: Gold and Silver; Copper; Iron; Tin; Abrasive Materials (Corundum, Garnet, Millstones); Mica; Quartz (Flint); Barytes, Monazite and Zircon; Tale and Soapstone; Precious Stones; Mineral Waters; Graphite; Coal; Peat; Stone (Granite, Sandstone, Marble, and Limestone); Sand and Gravel; Sand-lime Brick; Kaolin and Clay Products; and Heavy Black Sands.

* In the collection of the statistics of the production of the various minerals the State Survey has had the co-operation of the Department of Mineral Resources of the U. S. Geological Survey.

GOLD AND SILVER.**PRODUCTION.**

The deposits of gold and silver have been described in detail in previous reports;* and still another report is now being prepared which will supplement the previous publications on these subjects. For this reason no attempt is made in the present report to give any description of the new work that has been done in the mining of these metals.

There was a small increase reported in the production of gold and silver in 1905 as compared with that of 1904. The total coining value of this production in 1905 was \$149,369, which is an increase of \$6,312 as compared with \$143,057, the value of the production of 1904. Of the 1905 production \$129,153 was due to the value of the gold produced, an increase of \$5,229 as compared with \$123,924, the value of the 1904 production. The value of the silver production was \$20,216 as compared with \$19,133 in 1904, an increase of \$1,083. This production of 1905 consisted of 6,273 fine ounces of gold and 20,364 fine ounces of silver. The largest production of gold was from Montgomery County, with a production of gold valued at \$61,000 and of silver at \$1,600. Cabarrus County was second with a production of gold valued at \$22,836, and of silver at \$53.

On account of the death of Prof. George B. Hanna, Director of the United States Government Assay Office at Charlotte, N. C., in the spring of 1906, who had charge of the collecting and tabulating of the gold and silver statistics for North Carolina, it has been impossible this year to give these statistics in as much detail as in former years. Usually, it has been possible to give a list of all the counties producing gold, with the value of the production of each, and also to give a list of the principal producing mines. This year, however, it will simply be possible to give an approximate statement regarding the production of the principal producing counties, which is given in the following table.

* Bulletins 3 and 10, Economic Papers 6, 8 and 9, N. C. Geological Survey.

PRODUCTION OF GOLD AND SILVER IN 1905 BY COUNTIES.*

COUNTY.	1905.		
	GOLD.†	SILVER.†	TOTAL.†
Burke.....	\$ 1,000	\$ 15	\$ 1,015
Cabarrus.....	22,836	53	22,889
Catawba.....	3,500	81	3,581
Davidson.....	1,000	420	1,420
Guilford.....	9,000	30	9,030
McDowell.....	500	10	510
Mecklenburg.....	4,200	12	4,212
Montgomery.....	61,000	1,600	62,600
Nash.....	2,000	6	2,006
Rowan.....	7,200	17,600	24,800
Stanly.....	10,000	140	10,140
Union.....	4,948	29	4,977
Unknown.....	1,969	220	2,189
Total.....	\$129,153	\$20,216	\$149,369

As is seen from the above, the production of silver is obtained chiefly from Rowan County, which was the only county producing copper during 1905.

* The gold and silver statistics have been obtained through the courtesy of Mr. George C. Roberts, Director of the Mint, Washington, D. C. The counties given in this table do not represent all the producing counties, but the production has been given as far as possible to the principal producing counties and the balance is given as "Unknown." This latter undoubtedly includes a dozen or more counties.

† Coining value.

In the following table there is given the production of gold and silver in 1903 and 1904 by counties:

PRODUCTION OF GOLD AND SILVER IN 1903 AND 1904
BY COUNTIES.*

COUNTY.	1903			1904		
	GOLD.†	SILVER.†	TOTAL.†	GOLD.†	SILVER.†	TOTAL.†
Alamance -----	\$-----	\$-----	\$-----	\$ 23.26	\$.27	\$ 23.53
Anson -----				52.56	1.32	53.88
Burke -----	1,606.44	17.09	1,623.53	1,507.03	23.03	1,530.06
Cabarrus -----	3,237.23	85.93	3,323.16	14,889.80	193.08	15,082.88
Caldwell -----	41.10	.87	41.97	46.52	.41	46.93
Catawba -----	1,181.07	19.09	1,200.16	5,438.29	105.75	5,544.04
Chatham -----				96.74	1.60	98.34
Cherokee -----	1,144.52	5.91	1,150.43	123.76	.74	124.50
Clay -----	46.51	.29	46.80	57.90	.36	58.26
Cleveland -----	5,269.40	1.16	5,270.56	180.47	4.46	184.93
Davidson -----	230.12	161.52	391.64	1,102.77	590.91	1,693.68
Franklin -----	162.79	2.48	165.27	88.37	1.86	90.23
Gaston -----	196.84	2.85	199.69	217.88	4.71	222.59
Granville -----	562.68	2,258.97	2,821.65	610.07	1,189.05	1,799.12
Guilford -----	3,806.62	159.16	3,965.78	12,853.11	46.16	12,899.27
Halifax -----	423.81	2.63	426.44	178.54	1.45	179.99
Henderson -----	186.05	2.33	188.38	32.31	.37	32.68
Iredell -----	133.84	1.60	135.44	162.20	2.51	164.71
Lincoln -----	522.42	9.90	532.32	35.03	.84	35.87
Macon -----	93.02	.58	93.60	46.52	.30	46.82
McDowell -----	2,260.15	30.60	2,290.75	602.78	14.10	616.88
Mecklenburg ---	8,578.72	102.89	8,681.61	1,157.99	25.04	1,183.03
Montgomery ---	48,634.83	878.27	49,513.10	50,460.88	901.46	51,362.34
Moore -----	388.87	8.04	396.91	310.46	7.04	317.50
Nash -----	139.54	2.15	141.69	44.18	.95	45.13
Orange -----	351.46	5.11	356.57	23.26	.15	23.41
Person -----	1,096.15	8,632.24	9,728.39	171.50	2,734.51	2,906.01
Polk -----	602.21	4.22	606.43	192.78	1.86	194.64
Randolph -----	396.30	6.96	403.26	397.62	12.99	410.61
Rowan -----	1,852.39	4,119.21	5,971.60	4,163.72	12,852.09	17,015.81
Rutherford ---	1,322.20	16.91	1,339.01	484.95	3.24	488.19
Stanly -----	24,524.30	116.05	24,640.35	17,113.65	157.32	17,270.97
Union -----	3,101.84	95.68	3,197.52	9,677.08	224.56	9,901.64
Warren -----	139.54	1.75	141.29	359.07	2.36	361.43
Unknown -----	1,370.59	154.22	1,524.81	1,020.95	25.73	1,046.68
Total -----	113,603.55	16,906.66	130,510.11	123,924.00	19,132.58	143,056.58

* The gold and silver statistics have been obtained through the courtesy of Mr. Geo. B. Hanna, of the United States Government Assay Office, Charlotte, N. C.

† Coining value.

In the next table there is given the value of the gold and silver productions in North Carolina for the years 1882 to 1905, inclusive:

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA
FROM 1882 TO 1905.*

YEAR.	GOLD.	SILVER.	TOTAL.
1882	\$190,000	\$25,000	\$215,000
1883	167,000	3,000	170,000
1884	157,000	3,500	160,500
1885	152,000	3,000	155,000
1886	175,000	3,000	178,000
1887	225,000	5,000	230,000
1888	136,000	3,500	139,500
1889	145,000	3,878	148,878
1890	118,500	7,757	126,257
1891	95,000	6,465	101,465
1892	78,560	12,671	91,231
1893	53,600	17,325	70,925
1894	46,594	455	47,049
1895	54,200	520	54,720
1896	44,300	646	44,946
1897	34,600	388	34,988
1898	84,000	905	84,905
1899	34,500	388	34,888
1900	44,653	15,986	60,639
1901	60,410	34,023	94,433
1902	93,650	30,212	123,862
1903	113,604	16,907	130,511
1904	123,924	19,133	143,057
1905	129,153	20,216	149,369

* Coining value.

COPPER.

PRODUCTION.

The production of copper in 1905 was all from Rowan County and amounted to 10,000 tons of ore, of which the value of the copper contents was \$88,000. Reckoning the copper at 18 cents per pound, this makes the total copper production equal to 488,888 pounds. As compared with the production of 305,000 pounds, valued at \$36,600, in 1904, this is an increase of 183,888 pounds in quantity and of \$51,400 in value. All this ore was shipped to the smelters at Ducktown, Tennessee. In the following table there is given the production of copper in North Carolina from 1900 to 1905:

PRODUCTION OF COPPER FROM 1900 TO 1905.

YEAR.	CRUDE ORE MINED.	COPPER PRODUCED.	VALUE.
	<i>Tons.</i>	<i>Pounds.</i>	
1900	6,948		\$ 41,600
1901	10,398	512,666	76,900
1902	16,741	1,417,020	212,553
1903	4,106	458,133	67,037
1904	4,250	305,000	36,600
1905	10,000	488,888	88,000

COBALT.

During the past 18 months there has been considerable interest aroused in North Carolina regarding the location of deposits of minerals containing the metal, cobalt, due to the fact that Mr. Thomas Edison made a personal trip through the State apparently with the object in view of locating commercial sources of supply of this metal.

Cobalt is a metal that is very similar in its properties to nickel, and, with few exceptions, all minerals in nature that contain one of these metals contain also a small percentage of the other. In the reduction of the ores containing nickel and cobalt, they both go into the matte, which is afterwards refined and the two metals separated from each other. The demand for cobalt is not large and there is usually an over-production of this metal, which is obtained as a by-product from nickel ores. For this reason there has been but little direct prospecting for new sources of supply of cobalt. The demand for nickel, however, has constantly increased, so that prospecting has been carried on in many sections of the country for deposits of this metal. Up to the past two years all the cobalt produced in the United States and Canada was as a by-product either in nickel or lead mining and smelting, and there had been no direct mining for cobalt ores. Recently, however, new sources of supply of cobalt, containing but little nickel, have been found in Canada, which have resulted in the production of cobalt in some quantity, and this could be very largely increased if a sufficient demand should be created for this metal. These deposits are in Canada, on the line of Temiscuming and North Ontario Railroad, 90 miles northeast of Sudbury. These ores carry a considerable percentage of cobalt and are rich in silver, thus making the ore very profitable mining.

In the United States there has been no direct mining for ores of cobalt, and that which has been produced has been associated with the lead ores mined at Mine La Motte, Mo., which contained a considerable percentage of cobalt and a very small quantity of nickel. A matte is obtained which contains nickel, cobalt, and copper, and a small quantity of lead. This is afterwards refined and the nickel and cobalt separated out. The cobalt is put on the market in the form of cobalt oxide, which is worth approximately \$1 per pound.

The principal use of cobalt is in the manufacture of pigments, the principal one being known as cobalt blue. Some experiments have been made with cobalt for use in the manufacture of a specially hardened steel, which is the principal use of nickel. There is not, however, distinct enough difference in the properties imparted to steel by these two metals to warrant the use of cobalt as a steel or iron hardening metal so long as its cost is so much higher than nickel. If, however, a special use can be devised for it in the manufacture of storage batteries, as has been reported to be advocated by Mr. Thomas Edison, there should be a considerable increase in the demand for the metal, which would warrant more prospecting for sources of supply, although the present known supplies of this metal can satisfy a very large increase in the demand.

There are a number of minerals, principally sulphides, arsenides, and oxides, that contain a considerable percentage of cobalt, the principal ones being as follows:

Linnaëite.—This mineral, known also as cobalt pyrites, is a pale steel-gray brittle mineral, which tarnishes quite readily to a copper-red color. It is as hard as steel and has a specific gravity of about 5. It is a copper sulphide (Co_3S_4) and is quite commonly found in octahedral crystals, but also occurs massive.

Cobaltite.—This mineral, also known as tin-white cobalt and gray cobalt, is a cobalt arsenic sulphide (CoAsS) of a silver-gray to steel-gray color, sometimes having a tinge of red or violet. It is quite commonly found in pyritohedral crystals of silver-white color, and also occurs massive, when the color is apt to change to a steel-gray or a grayish color. It is as hard as steel and about 6.5 in specific gravity.

Smaltite.—This mineral has a tin-white to steel-gray color and is 5.5 to 6 in hardness, its specific gravity being about 6.5. It is brittle

and commonly occurs massive. In composition it is essentially a cobalt di-arsenide (CoAs_2).

These minerals have not been found in any large masses, but are usually found more or less sparingly disseminated through rocks and associated in veins with other minerals. In decomposing or altering these would form carbonates, sulphates and oxides, which would be entirely different in appearance from the minerals from which they have been derived. The more common alteration product would be the oxide which is apt to be found largely mixed with other oxides, but very little having been found in the free state.

One of the common minerals with which cobalt oxide is associated is a variety of psilomelane, a manganese oxide, known as wad or bog manganese. In certain localities this wad or bog manganese contains considerable cobalt oxide and is then known as asbolite. These minerals all have an iron-black to steel-gray color resembling somewhat a soft amorphous variety of graphite, for which they have occasionally been mistaken.

Asbolite.—This mineral is also known as black cobalt, earthy cobalt, and cobalt oxide. Its appearance is as mentioned above and it sometimes contains as high as 32 per cent. of cobalt oxide. In North Carolina none of the sulphides or arsenides, the original metallic minerals of cobalt, have thus far been identified, but in a number of localities the oxide or asbolite has been observed associated with manganese minerals. The principal localities where this asbolite has been found are as follows: A few miles southeast of Cary, Wake County, where black manganese cobalt mineral can be observed for a quarter of a mile outcropping occasionally on the surface. A small amount of prospecting has been done here, consisting of pits and cuts on the vein, which have shown that it is probably continuous for at least a quarter of a mile. In Gaston County there is a belt of micaceous schist extending in a general N. 20° E. direction that can be traced from Bessemer City northeastward into Lincoln County. These schists contain throughout their whole area numerous small seams, incrustations and stains of black manganese materials, which give reactions for cobalt. Some of this material is largely iron oxide that has more of a reddish or yellowish ocher color. At the Ormond iron mine, one mile southwest of Bessemer City, there is a considerable quantity of this material found mixed with the iron ore, and it may be that it was the cobalt which went into the pig-iron, and gave it the

hardness and toughness for which this iron was noted. At the Long Creek gold mine, situated about 6 miles northwest of Dallas, Gaston County, masses of the ore taken out of the Asbury shaft were thickly incrustated with mamillary masses of asbolite or earthy cobalt. About a mile northeast from the Long Creek mine, on the old Lincolnton-Yorkville (S. C.) road, near the summit of Cross or Peysour Mountain, a band of rock, about 15 feet wide, contains veins and seams of wad or asbolite. Following this vein in a northerly direction, it descends the west slope of Cross Mountain, and 50 years ago a number of openings were made on the asbolite seams. Some of this material was analyzed and gave 13.26 per cent of cobalt and nickel oxides, the larger amount being cobalt. The same formation can be traced in Lincoln County, where similar seams of wad are observed. The original minerals from which this cobalt oxide was derived may be one of the sulphides mentioned above, or some of the sulphides that contain both nickel and cobalt.

There are many other localities where psilomelane or wad has been found, but at the present time they have not been shown to contain cobalt. These are Scott's Hill, Burke County; near Lenoir, Caldwell County; at Gillespie, near Bakersville, Mitchell County; on Cove and Richmond creeks, Haywood County; near Buckhorn, Chatham County; near Murphy, Cherokee County; Franklin, Macon County; Webster, Jackson County; Zirconia, Henderson County; and Davidson River, Transylvania County.

The simplest test for cobalt is by fusing some of the powdered mineral with borax, the cobalt oxide giving to the resulting borax glass a deep blue color. This test is so delicate that it will show even traces of cobalt and can be used when a large percentage of nickel is associated with the cobalt.

IRON.

The iron deposits of North Carolina were not very extensively operated during 1905, and the only deposit that was a producer of this metal was the celebrated Cranberry mine at Cranberry, Mitchell County, which contains magnetic iron ore and furnishes a pig-iron of superior quality. A similar iron ore occurs in Ashe County and only its distance from railroad transportation prevents its being mined. There are other deposits of iron ore throughout the different counties of North Carolina that are not worked, principally on account

of their distance from sources of fuel and flux, or their distance from railroad transportation. There are some deposits, however, favorably situated on the railroad, such as the Ormond mine, Bessemer City, Gaston County, which should make profitable mining, even though the ore has to be shipped a considerable distance by rail. With any advance in the price of iron the deposits in Cherokee, Jackson, Chat-ham, and Gaston counties would, undoubtedly, be worked, and the ore shipped to furnaces located at Bristol, Tenn., Birmingham, Ala., or elsewhere.

PRODUCTION.

The production of iron ore in North Carolina during 1905 amounted to 56,282 tons, valued at \$70,352, and was obtained from Mitchell County. As compared with the production of 64,347 long tons valued at \$79,846, the 1904 production, it is a decrease of 8,065 tons in quantity and of \$9,494 in value. The Junaluska Iron Company of Andrews, Cherokee County, which produced a small amount of ore in 1904, reported no production in 1905. In the following table is given the production of iron ore in North Carolina from 1900 to 1905, inclusive.

PRODUCTION OF IRON ORE IN NORTH CAROLINA, 1900-1905.

YEAR.	AMOUNT LONG TONS.	VALUE.
1900	21,000	\$42,000
1901	2,578	4,997
1902	34,336	52,771
1903	82,851	78,540
1904	64,347	79,846
1905	56,282	70,352

TIN.

There was no production of tin ore in North Carolina during 1905, but there was much prospecting and development work carried on, especially at Kings Mountain, Cleveland County; near Bessemer City, Gaston County; and near Lincolnton, Lincoln County. At the old Ledoux mine, at Kings Mountain, a mill with rolls, jigs, and tables was erected, and the company operating this plant expect to handle not only the ores from this mine, but from other tin deposits that are being opened up in the vicinity. A small quantity of con-

centrates have been obtained from this property, but none have been put on the market.

At the Jones mine, 7 miles north of Kings Mountain and 3 miles northwest of Bessemer City, a small roll-mill with two Bartlett tables was erected and a small amount of the ore treated. The concentrates, however, have not been shipped. The property has been worked to the 100-foot level, and some very good ore has been exposed. There has not, however, been any large amount of ore blocked out.

Perhaps the most extensive development work has been carried on near Lincolnton, Lincoln County, by the Piedmont Tin Mining Company. The property of this company begins about 2 miles southwest of Lincolnton and extends in a general southwest direction for 2 miles, to the Little Catawba River, about midway between Long Shoal and South Side, two stations on the Carolina and Northwestern Railroad. Tin-bearing pegmatite has been exposed at a number of places throughout this area, and has shown the existence of two or more approximately parallel pegmatitic dikes, which are also following the laminations of the schists and gneisses. There were other pegmatitic dikes also observed that were cutting the dikes referred to above and the lamination of the country rock. The company have acquired by purchase and lease control of a property about 2 miles long and 1 mile wide, which has been prospected more or less over its entire area.

The country rock of this section consists of hornblende and mica gneisses and schists that are intersected by the pegmatitic dikes, which sometimes are cutting across the strike of the schists and then again following it and at other times have sent off apophyses which have forced their way between the laminations of the schist and gneiss. Occasionally, a mass of the pegmatite is encountered that has all the appearance of a boss. These dikes are very variable in width from a few feet up to 30 or more. They have the usual mineralogical character of ordinary pegmatitic dikes, except that for the most part they are tin-bearing. The position of the tin in these dikes was carefully noted, and in nearly all cases it was observed that the main portion of the dike carried little or no cassiterite (tin oxide), but that this mineral was confined to restricted portions of the dike, which, in nearly all cases, was near the contact of the pegmatitic dike and country rock. In these areas there was usually but little feldspar, and the dike was made up largely of quartz and mica. Occasionally,

where the pegmatitic dike was narrow, tin oxide was found scattered sparingly throughout the whole mass.

The work done by this company has made this section the most favorable one for studying the occurrences of these pegmatitic dikes and of the tin mineral which they contain. Beginning at the southwest end of the property, on a hill, just above the Little Catawba River, the company have sunk shafts and pits and made open cuts at various intervals from this point for a distance of 2 miles in a northeast direction to what is known as the Main Shaft mine, where the greater amount of underground work has been done. Wherever any pegmatitic dikes have been encountered in this prospecting, they have contained more or less tin oxide, but in very varying percentages. The work has also shown that the pegmatitic dikes are extremely variable in width, both on the strike and dip. There are two points, one known as the Henry shaft and the other the Main shaft, where considerable underground work has been done.

The Henry shaft, which is approximately 1 mile southwest of the Main shaft, is 60 feet deep, from the bottom of which a drift 30 feet long has been run in a N. 45° E. direction. In a distance of 18 feet this drift encountered a pegmatitic dike which proved to be 12 feet wide and had an approximate strike of N. 25° W. The main portion of this dike showed little or no tin oxide, but near its contact with the country rock tin oxide was encountered for a width of 1 to 2 feet. At the 45-foot level about 52 feet of drift has been run, which only showed a small amount of pegmatite at one point in the roof of the drift about 12 feet from the shaft.

At the Main Shaft mine, where most of the work of the company has been concentrated, two shafts have been sunk, one 102 feet deep and the other, which is 165 feet E. 12° S. from No. 1, is 40 feet deep, the two being connected on the 40-foot level. Near the mouth of the 40-foot shaft a pegmatitic dike was encountered near the surface and was followed on the surface for some distance in each direction by an open cut. In sinking this shaft pegmatite was encountered for only a part of its depth, and the foot of the shaft is entirely in the country rock. As far as can be determined, the pegmatite encountered in the shaft is simply an apophysis from the mass of pegmatite encountered on the surface, or else a small parallel dike. The 102-foot shaft has two levels, one at 40 feet and the other at 102 feet. From the 40-foot level the main drift is 198 feet 8 inches long and

extending beyond the 40-foot shaft. From this drift cross-cuts aggregating 720 feet have been made. The larger proportion of the work done on this level is entirely within the country rock, and the cross-cuts are very circuitous in their courses. They have proved that the pegmatitic dikes, of which there are evidently a number, are irregular in their course and vary considerably in width, both along the strike and dip. A large portion of the drifts and crosscuts on this 40-foot level are entirely within the country rock and is partly due to the irregularity of the pegmatitic dikes. At a number of points throughout the crosscuts and drifts on this level, winzes have been sunk in some instances on a pegmatitic dike and in others to encounter a supposed one that was dipping under the drift or crosscut. These winzes aggregate 67 feet of depth, making a total of 1,177 feet of development work on this level.

From the bottom of the shaft on the 102-foot level drifts have been run east and west for a distance of 158 feet, from which 33 feet of crosscuts have been made, making a total of 191 feet of development work on this level. A pegmatitic dike a few feet in width was encountered in the west drift, which was followed by the crosscuts.

There has been a total of 1,319 feet of underground development work at this Main Shaft mine, and although this has exposed in a number of places pegmatitic dikes which carry more or less tin, it has not as yet developed or blocked out any large quantity of ore. The dikes show the same characteristics regarding the tin oxide as was observed in those examined on other parts of the property, namely, that the larger proportion of the tin oxide is concentrated near the contact of the pegmatitic dike with the country rock and usually in seams from a few inches to a foot in width.

Although there has been this comparatively large amount of work accomplished during the past year on the tin deposits of the State, it has not as yet proved conclusively the real value of the Carolina tin deposits. It has, however, demonstrated that to make these deposits profitable will require economical and careful management. The work has also shown that the percentage of tin in the narrow portion of the pegmatitic dikes, near the country rock, will run rather high, perhaps as much as 4 to 8 per cent of tin oxide; but as this portion of the dike will vary from a few inches to possibly 2 feet, it will reduce the percentage of tin oxide in the rock necessary to remove in mining to from a fraction of one per cent to perhaps $1\frac{1}{2}$ per cent

tin oxide. Although these percentages of tin oxide in the vein are small, yet with careful management and tin at 30 cents per pound, they could be worked at a profit. With tin at the price it has been selling for during the past year, 48 cents, the chances of profit are, of course, much larger.

Tin mining is a very attractive mining proposition, on account of the scarcity of the metal and the large demand for it in the United States, which imported during 1905, 44,188 short tons valued at \$26,316,023, making an average price of 29.77 cents per pound. This is considerably below the price at which tin was sold in New York City during the year, which, to the middle of December, 1905, had reached 37 $\frac{3}{8}$ cents per pound. During the early part of 1906 it had reached 48 $\frac{1}{2}$ cents per pound. The reason for this rise in the price of tin has been that the consumption is largely in excess of the present supply, and stocks of tin that have been kept on hand have been consequently very materially diminished.

Although these high prices have stimulated prospecting for new sources of supply of tin ore, they have not resulted in locating any deposits capable of producing large quantities of this metal.

It is to be hoped that the future development work on the tin deposits in the Carolinas will be carried on in such a way as to block out bodies of ore which can be carefully sampled and their tin contents determined and a satisfactory method devised for saving the tin concentrates, provided the percentage of the tin mineral is high enough to warrant their being worked.

ABRASIVE MATERIAL.

The abrasive industry in North Carolina is not large, and since the closing down of the corundum mine at Cullasaja, Macon County, and the garnet mines at Sugar Loaf Mountain, Jackson County, the production of abrasives has been very small.

CORUNDUM.

Although there is a large demand for corundum, which the present supply does not begin to fill, yet there has been but very little activity in corundum mining in this State during the past year. One reason for this inactivity is the fact that the International Emery and Corundum Company of New York own three or four of the better

corundum properties in the State, including the Corundum Hill and Mincey mines, Macon County, and the Buck Creek mine, Clay County. This company has not worked any of these properties since they came into their possession and, as far as can be learned, has no intention of working them, but will sell same if a satisfactory price can be obtained. On account, however, of the length of time since these properties were operated, no purchaser would be justified in paying any large amount for these properties without first having obtained an option which would give sufficient time to open them up and find out their present condition. There is, undoubtedly, still a large quantity of good corundum in the Corundum Hill and Buck Creek properties, which, if mined and cleaned properly, would find a ready sale.

The only two properties that are being actively operated are in Clay County, one being the old Behr mine located in Clay County, near Elf P. O., on Shooting Creek, 6 miles southwest of Haysville, the county-seat. The nearest railroad point is Murphy, Cherokee County, which is 26 miles northwest of this mine. It was first opened in 1880 by Dr. H. S. Lucas, but was soon afterwards bought by Herman Behr & Co., of New York. Several car-loads of cleaned corundum are reported to have been shipped, but the mine remained closed from 1890, until it was reopened during the past year by Major H. P. Dunlap of Asheville, N. C. The corundum has been opened in a mass of peridotite rock, which can be traced for a distance of a little over 2 miles in a N. E.-S. W. direction, and near the northeast extension of this long narrow mass of peridotite. The main mass of this rock, which has a maximum width of a quarter of a mile, is one-half mile southwest of the Behr mine. Cutting this peridotite are dikes of dark-green amphibolite. The main country rock through which these two rocks have penetrated is a hornblende-gneiss. Corundum has been found sparingly at a number of places in the mass of peridotite, but usually close to its contact with the gneiss. It has also been found in certain portions of the amphibolite. At the present time the work that has been done on this corundum deposit consists of a large oval-shaped cut or pit approximately 80 feet long, 36 feet wide and 45 feet deep. From the bottom of this pit an inclined (60°) shaft has been sunk to a depth of 30 feet, from the bottom of which drifts were run N. E. and S. W. At a depth of about 40 feet the corundum and peridotite were found to dip under the hornblende-gneiss at an angle

of 60°, and conditions seem to indicate that a small block of gneiss has been enclosed by the peridotite, which may have influenced the greater separation of corundum at this particular point. Thirty-six feet northwest of the inclined shaft is a vertical shaft started from the surface which has been sunk to a depth of 90 feet. At the 75-foot level a drift was run S. E., encountering, in a distance of 30 feet, the corundum vein which had been worked in the old inclined shaft. The bottom of this 90-foot shaft, which could not be seen on account of its containing water, was reported as still being in barren peridotite rock. The old drifts from the incline were so badly caved in that it was impossible to re-examine them. The vein, however, where it was cut by the drift from the vertical shaft was examined, as was also all sides of the open cut and pit, but only a small amount of corundum was observed. This property is still being worked and giving employment to about six men.

To the north of the Behr mine, and across the mountain, is one of the most important corundum localities in North Carolina, which is known as the Buck Creek region, where the corundum is associated with the largest compact peridotite area in the State. The locality is in the narrow Buck Creek valley, about 20 miles southwest of Franklin, Macon County, and 21 miles northeast of Haysville, Clay County. The property, which includes the main mass of this peridotite formation, is owned by the International Emery and Corundum Company of New York, referred to above.

Near the northwestern end of this peridotite mass, where it is much narrower than the main mass, is the mine of the North Carolina Corundum Company, of Detroit, Michigan. The corundum has been found in a number of small veins of almost massive corundum, 3 to 6 inches thick. The company has erected a large mill for cleaning the corundum and a small amount of the cleaned product has been shipped. The property has not been operated very extensively during 1905, and for a considerable part of the year was shut down.

There has recently been published by the Survey a volume* on Corundum and the Peridotites of Western North Carolina, by Joseph Hyde Pratt and Joseph Volney Lewis, of which the following is a short review.†

*Copies of this volume can be obtained by writing Joseph Hyde Pratt, State Geologist, Chapel Hill, N. C., and enclosing 35 cents for postage, or 75 cents if a cloth-bound copy is desired.

† Journal of the Elisha Mitchell Sci. Soc., Vol. 22, 1906, p. 8.

Under the above title, Volume I of the North Carolina Geological and Economic Survey Reports has recently appeared. The scope of the work, however, is broader in many ways than this title indicates. It is a volume of 464 pages, and is illustrated by 45 plates and 35 figures in the text. While the report is the result of collaboration, the work has been divided so that, in the main, the mineralogical investigations have been conducted by Dr. Pratt, and the petrographical study of associated rocks has been the work of Professor Lewis. The preface states: "To only a limited extent have the authors been able to carry on field work together. The work for the most part has been done at different times, each working independently. Notwithstanding this fact and the somewhat different methods employed, each has been led to essentially the same conclusions in the interpretation of field observations. Especially is this true in regard to the theories of the origin and present relations of both the peridotites and the corundum."

A brief sketch of Geology of the State is given in Chapter I, with a somewhat fuller description of the belt of gneiss, granites and schists, constituting the mountain section of the west, and in which the peridotites and the corundum deposits of the State occur.

Chapter II deals with the peridotites and associated basic magnesian rocks, including four varieties of peridotites, four pyroxenites, four gabbroic rocks, an amphibolite, and three varieties of diorite. These are chiefly well-known types, with the exception of the pyroxenite, composed of the orthorhombic pyroxene, enstatite. This rock is somewhat commonly found throughout the region and forms many masses of considerable extent. The name *enstatolite* is proposed for this type, in conformity with the terms bronzitite and hypersthenite. These rocks are discussed in their relations to the belt of similar rocks, which extends the whole length of the eastern crystalline belt, from central Alabama through Georgia, South Carolina, North Carolina, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, the New England States, Quebec and Newfoundland.

Maps are given showing the distribution and relations of these rocks to the crystalline rocks in eastern North America and western North Carolina, besides several detailed maps of various portions of the belt of particular interest. The contoured map of western North Carolina is on a scale of eight miles to the inch, with the base printed in three colors, after the manner of the maps of the United

States Geological Survey. On this the "Conglomerates, quartzites, slates, etc., chiefly 'Ocoee,' correlated with Cambrian by the United States Geological Survey," and the "Gneisses, schists, granite, diorites, and other crystalline rocks of pre-Cambrian age," are clearly represented by tints, while the numerous dikes of peridotites and related rocks and the occurrences of corundum, chromite and asbestos, are shown in bright red.

The petrographic descriptions which constitute Chapter III are illustrated by half-tone reproductions of photomicrographs, showing the mineralogic and structural variations and modes of alteration of the rocks described. Following the general descriptions of these rocks throughout the Appalachian region, the distribution and petrographic characters are given in considerable detail for western North Carolina.

In addition to the numerous facies of primary rocks, secondary types are also described, including those mechanically derived from the primary types, now represented by gneisses, schists and gabbrodiorite, and also a series of hydrous alteration products, including serpentine, steatite, and chloritite (chlorite rock). The vast majority of occurrences of these basic rocks, while showing more or less alteration, are essentially fresh primary types, especially the pure olivine-rock, dunite, which is much the most common. Steatite is pretty widely distributed as an alteration product, but massive serpentine is almost entirely confined to an area extending about 15 miles north and south of the French Broad River. Even in these cases, however, the origin of the serpentine from peridotites of exactly similar character to those found in adjoining regions is very evident.

Chapter IV takes up the modes of alteration and decomposition of the peridotites, and five distinct processes are recognized: 1. Weathering; 2. Serpentinization; 3. Steatitization; 4. Chlorotitization; 5. Amphibolization. The processes of weathering and serpentinization are well-nigh universal, though developed only to a slight extent, except in a few localities. Alterations to talc, chlorite and amphibole are much more limited in their manifestations, but have given rise to many important rock masses. The various processes as affecting the peridotites of diverse composition are described minutely.

The long-vexed question of the origin of peridotites is taken up in Chapter V. The strong trend of modern thought toward the theory

of igneous origin is clearly brought out, and the correctness of this theory is abundantly substantiated by observations in North Carolina. The data presented upon this point are arranged under five heads: 1. Mineralogic characters; 2. Microscopic characters; 3. Gross structures; 4. Modes of occurrence; 5. Relation to the gneisses and schists. This is followed by a discussion of the general petrology of the peridotites and associated rocks in which the conception of genetic unity of the whole series is strongly emphasized.

It is pointed out, as a noteworthy fact, that many of these rock types are closely associated in almost every occurrence throughout the crystalline belt of eastern North America. Usually, one or another type preponderates in any particular region, but the associations are always essentially the same. Thus the peridotites, particularly dunite, prevail in North Carolina and Quebec, the pyroxenites in Pennsylvania, and the gabbros are very abundant in Delaware and Maryland. In fact the types represented in the various regions are almost identical, and the petrology is closely similar, except in relative abundance of the various types, and in degree of alteration.

In discussing the magmatic relations of the peridotites, anorthosites, amphibolites, etc., two generations of corundum are recognized. The greater part, including all deposits of commercial value, belongs to the first generation, and was formed by the crystallization of the excess of alumina in the original peridotite magma. A very small part, however, occurring in microscopic grains, has been produced by an excess of alumina arising from the corrosion of anorthite by the still molten magnesia magma. This process has produced the sheaths of intermediate minerals which form the *corrosion mantles*, so beautifully developed in some localities, or which, in some cases, entirely replace the anorthite or the olivine, as the case may be, with nest-like aggregates.

Regarding the age of the peridotites, the conclusion of the present writers may be summarized as follows: Sufficient data are not yet available for a satisfactory determination of the age of these rocks, but their intrusion was probably contemporaneous, or practically so, for the whole region from Newfoundland to Alabama. The peridotite belt lies in a region of great disturbance and intense metamorphism. This fact, together with the geological relations to the northward, suggests the hypothesis that the principal period of intrusion was closely associated with the orogenic movements which closed

the Lower Silurian (Ordovician) period. The distribution of these rocks may well mark to a great extent the axis of most intense folding and faulting. The latter Appalachian disturbances, at the close of the Carboniferous, have produced the lamination so often seen in these rocks, and have probably given occasion for later minor intrusions. This hypothesis is not offered as a final answer to the question of age of the peridotites. Much painstaking work yet remains to be done before an entirely satisfactory solution of this problem can be expected.

The chapter closes with a discussion of the relations of the secondary rocks, in which the attempt is made to trace the various laminated and hydrated alteration products back to their original types. Here the question is reached, whether the amphibolites, diorites, hornblende-schists, and hornblende-gneisses may not themselves have been derived from corresponding pyroxenite types, such as are met with in the Maryland and Delaware gabbro areas. The fact is pointed out that undoubted gabbro-diorites do exist in portions of the belt in North Carolina, and hence it is considered probable that many, if not all of these rocks, as well as similar rocks throughout the region, have had a like origin.

After a discussion of the physical and chemical properties of corundum in Chapter VI, is given a description of the various applications of the mineral in the arts, and an outline of the process of manufacture of the several types of corundum and emery wheels on the market.

Chapter VII deals with the modes of occurrence of corundum. In North Carolina the mineral is known in five types of igneous rock, namely, peridotite, pyroxenite, amphibolite, anorthosite, and pegmatite; in six metamorphic rocks, serpentine, gneiss, mica-schist, quartz-schist, amphibole-schist, and chlorite-schist. It is also found in gravel deposits of emery, whose relations are undetermined. These modes of occurrence are described in detail, and are compared with similar occurrences, when known, in other parts of the world. The deposits which have been of chief commercial importance in North Carolina have been associated with peridotites, and to a less extent with pyroxenites and amphibolites. The gravel deposits are of considerable interest on account of the corundum gems (ruby) and associated garnet gems (rhodolite) that have been found in some of them.

With the peridotites the corundum occurs chiefly in "peripheral or border veins," striking along the borders of many of the massive outcrops, and in "interior veins," extending from the borders at greater or less distance toward the center of the peridotite masses. In the pyroxenite and certain of the amphibolite occurrences the mode is similar. In other amphibolites the corundum is irregularly distributed in grains and larger plates and nodules through portions of the rock. Certain small pegmatite dikes, accompanying and penetrating both the peridotite and amphibolite, are found also to carry corundum. The corundum-bearing serpentine, amphibolites, and chlorite-schists are simply alterations of some of the foregoing types, with more or less dynamic disturbances and rearrangement of materials. Corundum-bearing belts of the gneisses and mica-schists, which sometimes pass into quartz-schists, have no apparent or probable relation with the peridotites, although occurring in the same region, and in some cases near the outcrops of these rocks.

The chief localities of corundum-bearing peridotite are in Clay, Macon, and Jackson counties, in the southwestern corner of the State, and most of the corundum-bearing gneisses, etc., are also found in the same counties. Certain scattered occurrences of corundum in amphibolite dikes and also in the gneisses are found east of the mountains, particularly in Iredell County.

"Other occurrences of corundum in America" extends the list of corundum-bearing igneous rocks to include granite, syenite, nepheline-syenite, Plumasite, norite, andesite, and monchiquite and adds crystalline limestone to the list of metamorphic corundum-bearing rocks. A brief description of each of these modes of occurrence is given with references to the literature of those that have been previously described. An additional list of "Modes of occurrence of corundum not found in America" adds to the number of corundum-bearing igneous rocks, kyschtmite tonalite, gabbro, quartz-porphry, trachyte, and basalt, besides contact-zones and inclusions in igneous rocks. To the metamorphic list are added corundum schists and porphyroids and graphite. These are followed in turn by brief descriptions, completing the list to date of all known modes of occurrence of corundum throughout the world.

The distribution of corundum is described in Chapter VIII. Like the peridotites, this is treated first with reference to the Appalachian belt as a whole, noting the occurrences in Alabama, Georgia, South

Carolina, North Carolina, Pennsylvania, New Jersey, Connecticut, and Massachusetts. Corundum in the western part of the country includes descriptions of occurrences thus far known in Montana, Colorado, and California. This is followed by a description of the North Carolina localities in detail, arranged by counties, beginning in the southwestern corner of the State. The chapter closes with the description of foreign corundum and emery deposits, including those of Canada, India, Turkey, and the Grecian Archipelago.

Chapter IX deals with the alteration of corundum and its associated minerals in great detail. The list of minerals found associated with corundum in North Carolina includes 62 species, each of which is described, with its mode of occurrence, and its relations to the occurrence of corundum. Many have chemical analyses and crystallographic characters also given. "Minerals associated with corundum not found in North Carolina" adds 12 more to this list, from various American and foreign localities.

The difficult question of the origin of corundum is discussed in Chapter X. This is prefaced by an account of the artificial production of corundum, and the origin of corundum in nature is introduced by a sketch of the various hypotheses that have been proposed during the last quarter of a century. After a discussion of the field relations and the later experiments in the production of artificial corundum, the conclusion is reached that the corundum was held in solution in the molten magma of the peridotite when it was intruded into the country rocks, and that it separated out among the first minerals segregated as the mass began to cool. The conclusion is also reached that the corundum in the quartz-schists and gneisses is the result of metamorphism of sandstones and shales, some of which were rich in alumina, perhaps in the form of bauxite, which, during metamorphism, crystallized out as corundum.

Chapter XI deals with corundum mining and milling. It is introduced by a historical sketch of corundum mining in the East, followed by a sketch of mining in America. "Suggestions to prospectors," and methods of mining and milling, as carried out at various plants, conclude the chapter.

Chapter XII discusses the chromite and other economic minerals of the corundum-peridotite belt. Chromite in promising quantities has been found at a number of the peridotite localities in western North Carolina, particularly in Jackson and Yancey counties. Its

origin and relations are discussed and the conclusion reached is essentially the same as for the origin of corundum in peridotites. A discussion of the chemical composition of chromite and its uses, and a description of the chromite localities of the region, with a summary of occurrence in other parts of the world, follow. The distribution and character of asbestos, nickel ores, serpentine, and limonite—minerals which, thus far, are of minor importance in the region—closes the chapter.

An appendix, consisting of a bibliography of American peridotites, and corundum and associated minerals, is not complete, perhaps, as regards the whole of North America, but is believed to be practically complete for North Carolina and the eastern crystalline region in general. There are also many references to foreign literature in foot-notes throughout the work, and the volume is closed with an elaborate index.

GARNET.

The demand for garnet for abrasive purposes is not very large, and the total amount produced in the United States since 1900 has varied from approximately 3,200 to 5,000 tons per year. There are many localities in North Carolina where garnet occurs in commercial quantity, but some of these are non-productive, on account of their distance from railroad transportation; others, which were formerly productive mines, have been shut down, but for what cause it is not known. The Sugar Loaf mine in Jackson County produced a quality of garnet for which there was considerable demand at a price higher than that paid for any other garnet on the market. The cost of production of this garnet was somewhat in excess of preparing most garnet, but the quantity of raw material is large and it could be put on the market in most any quantity desired. This property, however, was not operated at all during 1905.

The garnet deposit on Little Pine Creek, near Marshall, Madison County, produced a small amount during the past year.

A new, though small, source of supply of this mineral should be the garnet sand separated from the monazite concentrates obtained in mining this latter mineral in Burke, Iredell, Cleveland, and other counties in North Carolina. These concentrates sometimes contain as much as 20 per cent or more of garnet which is in the form of grain that has been rounded but very little, often having the appearance as though it has been crushed. A very clean separation of the

garnet from the other minerals can be made on the Wetherill magnetic separator, and, as this mineral would be a by-product, it could readily compete with any garnet on the market. The product would be of exceptional purity and the garnet would have a hardness equal to any garnet that is now being mined.

MILLSTONES.

Buhrstones, or millstones, are usually manufactured from a stone that varies from a sandstone to a quartz conglomerate. In North Carolina, however, buhrstones are being made from a granitic rock which occurs at Faith, Rowan County, and thus far wherever used have given perfect satisfaction. The general demand for millstones or buhrstones has been increasing during the past few years for use in grinding cereals, mineral paint ores, fertilizers, cement rock, barytes and other minerals, and for these purposes the Rowan stone should give good satisfaction. There was, however, a falling off in the production of millstones in 1905.

PRODUCTION OF ABRASIVES.

There were only five producers of abrasive materials in North Carolina. Of these, three were millstones and one each of garnet and corundum. The combined production of garnet and corundum in 1905 amounted to 115 tons, valued at \$9,000, as compared with 202 tons, valued at \$6,586, in 1904. This shows a decrease of 87 tons in quantity, but an increase of \$2,414 in value. This is due to the larger quantity of corundum mined in 1905 as compared with that of 1904, and a very large decrease in the quantity of garnet sold. There were 196 pairs of millstones valued at only \$2,652 produced in 1905, as compared with 208 pairs valued at \$6,500 in 1904. The quantity produced in these two years is almost equal, but the value of the 1904 production is over twice that of the 1905 production, due to the lower price of millstones and to the larger number of smaller stones made as compared with the previous year.

The total value of all abrasive materials produced in 1905 is \$11,652 as compared with \$13,086, the value of the 1904 production, a decrease of \$1,434. The production of abrasive materials from 1901 to 1905 inclusive is given in the following table.

PRODUCTION OF ABRASIVE MATERIALS, 1901-1905.

YEAR.	CORUNDUM.		GARNET.		MILLSTONES.		TOTAL VALUE.
	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	
	<i>Tons.</i>		<i>Tons.</i>		<i>Pairs.</i>		
1901-----	325	\$ 48,840	775	\$ 43,000			\$ 91,840
1902-----			260	10,040	50	1,425	11,465
1903-----			*403	12,250	63	902	13,152
1904-----			*202	6,586	208	6,500	13,086
1905-----	†1,150	9,000			196	2,652	11,652

MICA.‡

PRODUCTION.

Mica is one of the minerals for which North Carolina is especially noted, and of the total production of this mineral in the United States, North Carolina produces approximately four-fifths of the entire production. North Carolina mica is known as the standard mica and is the finest grade of mica on the market, and for those purposes where a sheet mica is desired, as for stoves, lamp-chimneys, etc., it cannot be surpassed. During 1905 the production of plate or sheet mica was 1,044,800 pounds valued at \$100,900, this being an increase of 434,679 pounds in quantity, but only of \$276 in value as compared with the production of 610,121 pounds valued at \$100,724 in 1904. This large increase in the quantity of mica produced, with comparatively no increase in the value, is due to the much larger production of small disks and rectangular sheets that are used so largely for electrical purposes. The scrap mica produced in 1905 amounted to 275 tons valued at \$3,375, an average of \$12.27 per ton. As compared with the production of 1904, of 341 tons valued at \$3,410, this is a decrease of 66 tons in quantity, and of \$35 in value. There is given in the following table the approximate value and distribution of the production of sheet mica by counties for the years 1900 to 1905 inclusive.

* Including production of corundum.

† Including production of garnet.

‡ For a more detailed discussion of mica, see reports for 1901 and 1904, Economic Papers 6 and 9 respectively.

PRODUCTION OF MICA IN NORTH CAROLINA DURING 1900 TO 1905,
BY COUNTIES.

COUNTY.	1900.	1901.	1902.	1903.	1904.	1905.
Ashe	\$-----	\$-----	\$-----	\$ 1,000	\$-----	\$-----
Buncombe			250	300		
Caldwell					10,000	
Haywood	11,000	11,500	20,000	18,000	34,500	33,710
Jackson	7,000	8,740	5,700	5,500	924	7,900
McDowell	1,000	500	600	1,000		
Macon	5,200		4,000	3,500		1,500
Madison						90
Mitchell	26,722	33,506	28,203	29,000	21,500	17,950
Stokes	1,000		1,000	7,500		
Transylvania	500	600	750	500		600
Watauga						350
Yancey	12,788	25,003	21,150	20,000	34,000	38,800
Total	65,200	79,849	81,653	86,300	100,724	100,900

QUARTZ (FLINT).

The quartz considered under this head is vein quartz, which is used for a variety of purposes, such as in the manufacture of pottery, for packing, for fluxing purposes, as an abrasive material, manufacture of scouring soaps, as a wood-filler, and in the manufacture of glass. In North Carolina the only flint that has been mined has been for fluxing and packing purposes.

During 1905 quartz was mined in Cherokee County for fluxing purposes, being used by the Tennessee Copper Company in their copper furnaces at Ducktown, Tenn. The Oliver mine in Mecklenburg County produced considerable quartz which was used for packing purposes. With the establishment of potteries in North Carolina there should be a considerable demand for quartz to be used for this purpose. Besides the above quartz, there is a great deal of quartz sand that is used in the manufacture of brick and other clay products, which, however, is not treated under this head, but is taken up under the head of Sand.

PRODUCTION.

The total production of quartz during 1905 was 32,648 tons valued at \$13,659 as compared with 32,972 tons valued at \$36,269, the production of 1904. This is a decrease of 324 tons in quantity and of \$22,610 in value. This large falling off in value is due to the low value accredited to the production from Cherokee County used for fluxing purposes. This value was but little over 30 cents per ton. In the table below is given the production of quartz in North Carolina for the years 1901 to 1905 inclusive.

PRODUCTION OF QUARTZ IN NORTH CAROLINA, 1901-1905.

YEAR.	QUANTITY.	VALUE.
	<i>Tons.</i>	
1901	3,000	\$ 7,500
1902	4,500	11,250
1903	29,462	36,827
1904	32,972	36,269
1905	32,648	13,659

BARYTES.

PRODUCTION.

The production of crude barytes in North Carolina during 1905 amounted to 5,544 tons valued at \$21,670. This production is a decrease of 7,869 short tons in quantity and of \$12,260 in value as compared with 13,413 short tons valued at \$33,930, the production of 1904. The average value per ton received for the 1905 production was \$3.91, which is \$1.38 more than the average value, \$2.53 per ton, of the 1904 production. The value received for the North Carolina barytes represents the crude mineral that has been mined and handcobbled ready for shipment to the mill, but without its being subjected to any other cleaning process. This production was obtained from Madison and Gaston counties, with by far the larger amount from the former county. In the following table there is given the production of barytes in North Carolina for the years 1901 to 1905 inclusive:

PRODUCTION OF CRUDE BARYTES IN NORTH CAROLINA, 1901-1905.

YEAR.	QUANTITY, SHORT TON.	VALUE.
1901	6,890	\$20,865
1902	14,679	44,130
1903	6,835	21,347
1904	13,413	33,930
1905	5,545	21,670

MONAZITE AND ZIRCON.*

INTRODUCTION.

During the past five years there has been a considerable advance made in the manufacture of various forms of apparatus for lighting purposes. These investigations and inventions have led to the practical introduction of certain metals and metallic oxides into the arts which before this time had little or no commercial value. With the demand for these metals and metallic oxides there at once arose the question of their sources of supply, which has resulted in the mining of a number of minerals that were formerly supposed to be extremely rare in their occurrence, but which have now been found in considerable quantity. Experiments are being carried on with still other metals in regard to their usefulness for the manufacture of various incandescent and electric lamps.

The metals and the metallic oxides that are now being used and experimented with are tantalum, tungsten, cadmium, zirconia, thorium, yttria, and cerium, lanthanum, and didymium oxides. With the exception of cadmium, all these materials are being used commercially in the manufacture of different lamps and are obtained from the following minerals: Monazite, zircon, gadolinite, columbite, tantalite, wolframite, and hübnerite. These minerals and their occurrences have been described in detail in the reports for 1903 and 1904. The use of cadmium for lighting purposes is still in the experimental stage, and, although cadmium lamps have been made, they are still principally of scientific interest. As far as is known, no cadmium lamp has been made that would have a practical commercial value.

Of these minerals that now have a commercial value, monazite, zircon, and columbite have been found in North Carolina, and the two former are at the present time found in greater quantity in this State than in any other.

MONAZITE.

The demand for the mineral monazite, which contains the oxides used in the manufacture of mantles for the Welsbach and other incandescent gaslights, is constantly increasing, and many inquiries have been received during the past year for information regarding the source of supply of this mineral, not only for domestic, but also for

* U. S. Geological Survey, pamphlet Mineral Resources, 1905.

foreign consumption. Although monazite has been found sparingly at many localities throughout the United States, the Carolinas are still the only States that are producing this mineral commercially; and by far the larger amount is produced in North Carolina. During 1905, however, a probable new source of supply of this mineral has been worked out by the investigations that have been carried on at the concentrating plant of the United States Geological Survey at Portland, Oregon, which has been testing systematically the black sands of the Pacific slope as to their mineralogical contents. The results of this investigation have shown the presence of some monazite and more zircon in many of these sands, especially in those from Oregon and Idaho. By using the Wetherill magnetic separator an almost perfect separation can be made of both the zircon and monazite. The results of this investigation of the black sands will be published in detail as a bulletin of the United States Geological Survey and will give the various localities where monazite has been found in the sands, and its percentage.

In the Carolinas the monazite districts have been pretty thoroughly bounded, but occasionally a new section is discovered showing a sufficient quantity of monazite to make mining profitable, and thus extending the boundary slightly. In Greenville County, S. C., in the vicinity of Lenneman, in Grove Township, considerable monazite has been found in the creeks and branches, and during the past year some of this material has been shipped.

An interesting occurrence of monazite has been found in Queensland.* It has been known for some time that monazite occurs sparingly in the beach sands on the coast of Queensland, and that probably the most promising deposits are near the mouths of the Tweed and the Johnstone rivers. These deposits have not as yet been proved to contain this mineral in commercial quantities. The finding, however, of the monazite in these sands has led to further search which resulted in locating monazite in the original rock in two localities, namely, the Walsh and the Tinaroo mineral fields. Regarding these Mr. Dunstan says:

The monazite was observed to occur in pure crystalline masses, sometimes several pounds in weight, and also in small cleavable grains. Both forms are irregularly disseminated in quartz, black mica (biotite), and chlorite mica, and are in association with wolframite, molybdenite, scheelite, tinestone, and mispickel.

* Dunstan, B., Acting Government Geologist, Mining World, August 26, 1905.

With the exception of wolframite, these associated minerals are only in comparatively small quantities. The deposits containing the monazite are in granite country, but close to quartz-porphyry and slate. In the granite, and also at the junction of this rock with the porphyry and slate, irregular masses of greisen have been formed from the alteration of the granite, and it is in this, following closely the behavior of the wolframite, that the monazite deposits are to be found.

It is not improbable that the monazite in these deposits may become of commercial value, especially as it could be obtained as a by-product in mining the wolframite ore.

An interesting mineral, thorianite, was discovered early in 1905, associated with corundum, zircon, tin, topaz, spinel, etc. The mineral was first found by Mr. W. D. Holland in the refuse from gem washing near Balangoda, Ceylon, and was supposed to be uraninite or pitchblende, but upon analysis it was found to contain a very large percentage of thorium. The analysis of the mineral is as follows:*

Analysis of Thorianite.

Thorium oxide	76.22
Cerium, lanthanum, and didymium oxides.....	8.04
Zirconium oxide	Trace.
Uranium oxide	12.33
Ferric oxide	.35
Lead oxide	2.87
Silica	.12
	99.93

The specific gravity of the mineral is given as 9.32, and it was observed in black cubical crystals, which are fairly hard and give a brown streak. According to Mr. W. F. Peterd† the powdered thorianite dissolves readily in dilute sulphuric as well as in nitric acid. It has also been shown to be highly radio-active because of its uranium contents.

It is not improbable that this new mineral may be found in certain localities, in North Carolina, where tin, topaz, zircon, and monazite are found. According to the reports on this mineral, it is one that could be more easily utilized as a source of thorium than monazite, and as it has a much higher percentage of this compound it would be much more valuable.

* Dunstan, Wyndham R., Ceylon Mineral Survey No. III; Mining Engineering (London), March, 1905, and Min. Mag., May, 1905.

† Min. World, Sept. 16, 1905.

In view of the large increase in the production of monazite in 1905 as compared with that of 1904, of the new companies organized that require thoria in their manufactured products, and of the inquiries that have been received from abroad, any deposit that contains monazite or any other thoria mineral in apparent quantity is worthy of careful investigation.

TANTALUM MINERALS.

The tantalum minerals are in demand on account of their containing the metal tantalum, which is used at the present time only in the manufacture of very fine wire for use in the construction of what is known as the tantalum lamp. Both the occurrences of the tantalum minerals and the tantalum lamp were described in detail in the report for 1904, and much has been written regarding the lamp in various scientific and commercial magazines during 1905, indicating its successful commercial use. In a recent paper read at the electrical convention in Denver and published in part in the *American Inventor*,* Dr. Louis Bell makes the following statements regarding the value of this lamp:

The mean result of various tests of lamps were: From clear globes, 22.2 candlepower at 1.85 watts per candlepower, and from frosted globes, 19.08 candlepower at 2.1 watts per candle. It is interesting to note that the clear lamp gives just about one candlepower per inch of incandescent filament, which implies an intrinsic brilliancy of somewhere about 500 candlepower per square inch of filament—a figure much higher than in the ordinary incandescent. As illuminants the lamps are certainly very excellent, but their introduction raises some most interesting questions for the central station operator. Putting aside all the petty questions that will be raised about the new lamp for commercial reasons, the broad fact remains that we are here dealing with a *bona fide* 2-watt lamp having a life fairly comparable with the carbon filament lamps now customarily in use. Moreover, it is a competitor of these, socket by socket, and not as a substitute, with particular requirements, as in the case of the Nernst lamp, or the very small arcs. There is some doubt as to the life of the tantalum lamp when exposed to unusual vibration, which may perhaps bar it in some special locations, but for the every-day work of the central station there is good reason to believe it generally applicable.

Its price can hardly be said to be fixed in this country, but abroad, in Berlin, it is about \$1 (four marks), which will give at least a fair line on its commercial results. On this basis, and with power at 10 cents per kilowatt hour, one finds, taking the new lamp on its 600-hour rating, that the cost of its 12,000 candle hours, including the lamp, amounts to \$3.40. The same number of candle hours from a lamp giving a mean efficiency of 3.25 watts per candle would cost \$3.90,

* *American Inventor*, July, 1905.

exclusive of lamps; that is, the consumer could afford to pay \$1 for the new lamp better than to take the old ones free. With power as low as 5 cents per kilowatt-hour, the user of tantalum lamps could afford to pay only 75 cents per lamp, as against getting carbon lamps free. This means that a sliding scale of discounts for lamps according to quality could be made to catch the consumer at all prices ordinarily charged for current by central stations.

The writer has examined a number of tantalum lamps and used some for a short time. The light is nearly white, like the Nernst or the acetylene light, and quite agreeable, though it will usually be found too bright unless a ground glass or frosted globe is used. It was noticed that there was more or less tendency for the tantalum filament to snap or break when subjected to an unusually great vibration, especially after the lamp had been used for some time. This difficulty, however, will very probably be overcome with further experiments as the lamp is more fully perfected. As yet it has not been introduced to any great extent in this country, but as it becomes better known it will undoubtedly have a large use. The tantalum lamp does not require any new fixtures, as it fits any socket in which the ordinary incandescent carbon lamp is used.

Although columbite has been found at a number of localities in Mitchell and Yancey counties, there has not been any production of this mineral.

ZIRCON.

This mineral is mined for its zirconia content, which is used, together with yttria and other rare earth oxides, in the manufacture of the glower for the Nernst lamp. At the present time North Carolina is the only State producing zircon commercially.

PRODUCTION.

During 1905 the total production of monazite in North Carolina was 894,368 pounds valued at \$107,324. This is an increase of 208,369 pounds in quantity and of \$27,886 in value as compared with 685,999 pounds valued at 79,438, the production of 1904. The above quantities in each case represent the cleaned sand containing from 85 to 99 per cent monazite. This production was obtained from the following counties: Burke, Cleveland, Lincoln, McDowell, and Rutherford.

The 1905 production of zircon amounted to 8,000 pounds valued at \$1,600, and was obtained from Henderson County. This makes

the total production of these minerals mined for use in the manufacture of various lighting apparatus amount to 902,368 pounds in quantity and valued at \$108,924. There is given in the table below the production and value of monazite and zircon mined in North Carolina from 1893 to 1905 inclusive:

PRODUCTION OF MONAZITE AND ZIRCON IN NORTH CAROLINA
FROM 1893 TO 1905.

YEAR.	MONAZITE.		ZIRCON.	
	POUNDS..	VALUE.	POUNDS.	VALUE.
1893	130,000	\$ 7,600		
1894	546,855	36,193		
1895	1,573,000	137,150		
1896	80,000	1,500		
1897	44,000	1,980		
1898	250,776	13,542		
1899	350,000	20,000		
1900	908,000	48,805		
1901	748,736	59,262		
1902	802,000	64,180	2,000	\$ 380
1903	773,000	58,694	3,000	570
1904	685,999	79,438	1,000	200
1905	894,368	107,324	8,000	1,600

TALC AND SOAPSTONE.

The mining of talc in North Carolina represents one of the more important mining industries in the State and one grade of talc which is obtained from the Hewitt mine in Swain County is as fine a quality of talc as is produced anywhere. The demand for this particular talc is far beyond the supply and inquiries are constantly being received asking for information regarding new sources of supply similar in quality to the Hewitt talc. This talc is used in the manufacture of tailor's pencils, boiler-maker's pencils, gas tips, etc. Talc suitable for grinding into powder for use in the manufacture of talcum powders, soaps, etc., occurs quite extensively in both Swain and Cherokee counties. Pyrophyllite and compact talc or soapstone steatite is mined to a small extent and used, after being ground to a powder, for foundry facings, in the manufacture of paper, etc.

With the exception of a small amount of compact talc or soapstone that is quarried in the mountain counties and used for fire-places, chimneys, etc., there is none of it used for manufactured articles, such as tubs, table-tops, griddles, etc. This is due principally to the lack of railroad facilities. Soapstone deposits that are worthy of

notice and that may prove of value when railroad transportation reaches them are located about 2 miles west of Beaver Creek, Ashe County. At several places quarries have been opened and good material obtained for local use in fire-places, etc. The individual deposits are lens-shaped masses, with a thickness up to several feet long in the enclosing schists, or associated with partially altered peridotite rocks. These lenses show very few fractures or joints, and some are capable of yielding tough, good-sized blocks or slabs. The soapstone saws readily, even though it carries a considerable quantity of only partially altered asbestiform tremolite.

The demand for talc for grinding and also for cutting into pencils, gas tips, etc., is constantly increasing, and at the present time the total production in the United States is not equal to the domestic demand. This scarcity has caused an increase in the price of the better quality of talc and has also caused a considerable quantity of Bavarian soapstone or steatite to be imported. Thus, any new property is worthy of investigation, as many of the larger producers and manufacturers of talc are on the lookout for deposits of talc suitable for their purposes.

PRODUCTION.

During 1905 the total production of talc and soapstone, with the exception of that mined in the mountain counties and cut into slabs for chimneys, etc., amounted to 4,035 tons valued at \$74,690. This is an increase of 234 tons in quantity and of \$9,032 in value as compared with 3,801 tons valued at \$65,308, the production of 1904. The counties making this production were Swain, Cherokee, and Moore, given in the order of the importance of their productions. There were a total of five producers, the same as for the previous year. Besides the above, there was some soapstone quarried, principally in Ashe County, used for chimneys, fire-places, etc.

Very little of the talc produced is sold in the crude state, and, therefore, the value given for the talc production represents the manufactured products, and the production is classified as it is marketed, as ground, manufactured, rough, and for chimney purposes. In the table below is given the condition in which the 1905 production is marketed, together with that of the years 1903 and 1904:

PRODUCTION OF TALC AND PYROPHYLLITE IN NORTH CAROLINA
DURING 1903, 1904, AND 1905.

CONDITION IN WHICH MARKETED.	1903.		1904.		1905.	
	QUAN- TITY, SHORT TONS.	VALUE.	QUAN- TITY, SHORT TONS.	VALUE.	QUAN- TITY, SHORT TONS.	VALUE.
Ground talc for powders, etc. -----	3,762	\$ 37,606	3,163	\$ 32,217	3,529	\$ 39,007
Talc cut into pencils, gas tips, etc. -----	265	27,615	208	28,673	205	32,568
Talc sold crude -----	1,304	11,763	430	4,417	301	3,115
Soapstone cut into slabs for chimneys, etc. -----				175		250
Total -----	5,331	76,984	3,801	65,483	4,035	74,940

The next table shows the quantity and value of talc and soapstone produced in North Carolina from 1898 to 1905 inclusive:

PRODUCTION OF TALC AND SOAPSTONE IN NORTH CAROLINA,
1898 TO 1905 INCLUSIVE.

YEAR.	QUANTITY.	VALUE.	YEAR.	QUANTITY.	VALUE.
	<i>Short Tons.</i>			<i>Short Tons.</i>	
1898 -----	1,695	\$ 27,320	1902 -----	5,239	\$ 88,962
1899 -----	1,817	31,880	1903 -----	5,331	76,984
1900 -----	4,522	75,308	1904 -----	3,801	65,483
1901 -----	5,819	77,974	1905 -----	4,035	74,940

PRECIOUS STONES.

The precious stones or gem minerals of North Carolina have been described in some detail in previous reports* and there is now in press a bulletin on the Precious Stones of North Carolina by Dr. George F. Kunz, of Tiffany & Co., New York City.

PRODUCTION.

The total value of the production of precious stones of all kinds in North Carolina during 1905 was \$3,350, which is a decrease of \$6,250 as compared with \$10,600, the value of the 1904 production. This large decrease is due largely to the fact that the beryl mines at Spruce Pine were only operated a very small portion of the year.

There is given in the following table the production of precious stones in North Carolina since 1900.

* Economic Papers 6 and 9; Vol. I, N. C. Geological Survey.

PRODUCTION OF PRECIOUS STONES IN
NORTH CAROLINA SINCE 1900.

YEAR.	VALUE.
1900	\$12,020
1901	24,245
1902	5,300
1903	1,525
1904	10,600
1905	3,350

MINERAL WATERS.

The production and sale of mineral waters in North Carolina, while it has not yet reached a very large industry, has possibilities of becoming an industry of considerable value to the State. Most of the water that is bottled and sold is used for medicinal purposes, and there is very little that is marketed which could be called a purely table water. Spring water is being used more and more for table use, and North Carolina has springs of large flow whose water is pure, and if once introduced on the market would undoubtedly find wide favor as table water. During 1905 there were 10 springs that reported sales as follows:

Alkalithia Spring, Alkalithia Springs, Alexander County.

Barium Rock Spring, Barium Springs, Iredell County.

Buckhorn Lithia Spring, Bullock, Granville County.

Jackson Spring, Jackson, Moore County.

Mida Spring, near Charlotte, Mecklenburg County.

Panacea Spring, near Littleton, Halifax County.

Red Spring, Red Springs, Robeson County.

Seven Springs, near Goldsboro, Wayne County.

Thompson Bromine-Arsenic Spring, Crumpler, Ashe County.

Vade Mecum Spring, Stokes County.

Many of these springs have hotels run in conjunction with them, having a total accommodation for about 1,000 people. Besides these springs that have made sales of water, there are a large number of springs located throughout North Carolina that are used in connection with resorts, such as the Haywood White Sulphur Springs, Waynesville, Haywood County; the Blackwood Sulphur Springs near Alexander, Buncombe County; the Hot Springs at Hot Springs, Madison County; the springs at Sapphire, Jackson County, etc.

PRODUCTION.

The total amount of mineral water bottled and sold in North Carolina during 1905 amounted to 201,000 gallons valued at \$38,755. As compared with 145,800 gallons valued at \$21,902 sold in 1904, this is an increase of 55,200 gallons in quantity and of \$16,853 in value. In the following table there is given the production of mineral waters in North Carolina since 1901:

PRODUCTION OF MINERAL WATERS IN NORTH CAROLINA SINCE 1901.

YEAR.	AMOUNT, GALLONS.	VALUE.
1901	375,700	\$42,167
1902	104,400	18,795
1903	83,100	13,085
1904	145,800	21,902
1905	201,000	38,755

GRAPHITE.

PRODUCTION.

The occurrences and uses of graphite have been described in detail in previous reports on the Mining Industry.* The production of this mineral has never amounted to a great deal in this State, and for the most part has been confined to one county. During the past year the production only amounted to 100 tons valued at \$475, and was all obtained from Wake County. As compared with the production of the previous year, it is the same in quantity, but a decrease of \$50 in value. In the following table there is given the production of graphite from 1901 to 1905 inclusive:

PRODUCTION OF GRAPHITE IN NORTH CAROLINA FROM 1901 TO 1905.

YEAR.	QUANTITY.	VALUE.
	<i>Tons.</i>	
1901	95	\$ 559
1902	830	4,300
1903	50	248
1904	100	525
1905	100	475

* Economic Papers 6, p. 68; No. 8, p. 48; No. 9, p. 62.

COAL.

The Chatham and Moore County coal areas are the only producers of coal in North Carolina. These deposits have been thoroughly exploited and it has been shown that the field is not very extensive or capable of being developed into a very large productive region. The seams of coal are faulted in many places, which, together with their narrow width, makes mining expensive. The output of the past few years has been very irregular, and practically all of the production has been made from the Cumnock mines.

PRODUCTION.

The first record of the production of coal in North Carolina is in the report of the United States Census for 1840, which states a production of 3 tons was obtained. From that time until coal was mined during the Civil War for use by the Confederate Government, there is no record of any coal being produced. From 1862 to 1867 the production was from 20,000 to 30,000 tons a year. It then began to fall off until 1873 the production was reported as 10,000 tons. From that year until 1880 there was no coal produced. For the next ten years the production amounted to only 222 to 500 tons per year. In 1889 the Cumnock or Old Egypt mines were reopened and have been producing ever since, although the production has been very erratic. The year of greatest production was 1899, when the quantity of coal produced was 26,896 tons.

During 1905 the production only amounted to 1,557 tons valued at \$2,336, averaging \$1.50 per ton. As compared with the production of 7,000 tons valued at \$8,820 in 1904, this is a decrease of 5,443 tons in quantity and of \$6,484 in value. Over two-thirds of this coal was sold to the local trade or used by employees. In the following table is shown the distribution of the coal product of North Carolina for the years 1901 to 1905.*

* U. S. Geological Survey; mineral resources separate on Coal, 1906.

DISTRIBUTION OF THE COAL PRODUCT OF NORTH CAROLINA, 1901-1905.

YEAR.	LOADED AT MINES FOR SHIP- MENT.	SOLD TO LOCAL TRADE AND USED BY EMPLOY- EES.	USED AT MINES FOR STEAM AND HEAT.	TOTAL QUAN- TITY.	TOTAL VALUE.	AVERAGE PRICE PER TON.	AVERAGE NUMBER OF DAYS ACTIVE.	AVERAGE NUMBER OF EM- PLOYEES.
	<i>Short Tons.</i>	<i>Short Tons.</i>	<i>Short Tons.</i>	<i>Short Tons.</i>				
1901-----	10,000		2,000	12,000	\$ 15,000	\$ 1.25	300	25
1902-----	20,400	100	2,500	23,000	34,500	1.50	285	40
1903-----	14,429	87	2,793	17,309	25,300	1.47	264	49
1904-----	4,600	300	2,100	7,000	10,500	1.50	240	25
1905-----	461	1,096		1,557	2,336	1.50	60	15

The next table shows the production of coal in North Carolina since 1890, when the Cumnock mine was reopened.

COAL PRODUCTION IN NORTH CAROLINA FROM 1890 TO 1905.

YEAR.	QUANTITY.	YEAR.	QUANTITY.
1890	10,262	1898	11,495
1891	20,355	1899	26,896
1892	6,679	1900	17,734
1893	17,000	1901	12,000
1894	16,900	1902	23,000
1895	24,900	1903	17,309
1896	7,813	1904	7,000
1897	21,280	1905	1,557

PEAT.

The peat deposits of North Carolina are beginning to attract considerable attention, and during the past year many inquiries have been received regarding them. This is due partly to the many uses for which peat is adapted, the more important one being as a fuel, usually in the form of briquettes. It is found in swamps, marshes and bogs, where the drainage is hindered sufficiently to permit of vegetable growth. This accumulates and slowly decays under water, becoming constantly deeper. As examined, a peat deposit will usually show on top a layer of living vegetable matter; underneath this a mixture of partly decayed plants still showing well-defined fiber; and below this the spongy to black peat in which there may be a total absence of any fiber.

Swamps and marshes in which peat occurs may be either fresh-water swamps or marine swamps and marshes, and both these types are abundant in what is known as the "swamp lands" of eastern North Carolina, in many of which there are vast deposits of peat of varying quality and purity. There are also bogs and swamps in the Piedmont plateau and mountain regions of the State that may contain deposits of peat that are worthy of investigation.

In appearance, peat is often fibrous, although in many samples but few fibers can be distinguished. It is brownish to black in color, the latter representing the more thoroughly decomposed variety, which is more or less spongy and waxy and contains few or no fibers, while the brownish color is of the less decomposed peats, which are loose in texture and decidedly fibrous. When the peat is first taken out of these swamps it contains a very large percentage of water, the greater portion of which is readily lost by evaporation, but it requires a rather high temperature to eliminate all the water. Besides the decayed vegetable matter, peat contains more or less mineral matter which constitutes the ash. This often consists largely of clay, iron oxide, and calcium carbonate, and varies in peat, which will make a good fuel from 3 to 10 per cent.

The uses of peat are quite varied, the chief one being as a fuel. For this purpose it may be used directly after being dried, or after being manufactured into briquettes, the latter giving better satisfaction and greater heating efficiency. It can also be used in the manufacture of coke with by-products, such as gas, ammonia, tar, etc. It could also be used in the production of gas. For these uses, especially as a fuel in the form of briquettes, the deposits of eastern North Carolina are worthy of most serious consideration and thorough investigation.

The fibrous and spongy nature of the peat makes it of value for use as an absorbent in the manufacture of paper and for litter.

For agricultural purposes peat can be used to advantage, for its nitrogen content, and for this purpose the deposits of eastern North Carolina offer a promising field for investigation. It can also be used in packing as a non-conductor of heat and sound, and as a preservative for packing perishable articles, such as fish and fruits, for transportation.

During the coming year it is planned to thoroughly investigate the peat deposits of the State and to prepare for publication a report upon their occurrence, extent, chemical composition, value, etc.

The State Geologist would appreciate it if any one owning land containing peat will notify him of the extent of the bog or swamp and also send sample of the peat.

STONE.

INTRODUCTION.

There has recently been published by the North Carolina Geological and Economic Survey a report on the Building and Ornamental Stones of the State, which was prepared by Prof. Thomas L. Watson and Mr. Francis B. Laney, with the collaboration of Dr. George P. Merrill. This report represents nearly three years of field and laboratory work, and shows that North Carolina is well supplied with a great variety of building stone materials, particularly those of a granitic type. With perhaps the possible exception of Georgia, it is better supplied both as regards quality and variety than any of the other Appalachian States south of New England. When this fact is taken in connection with the mildness of the climate, which permits of a long season of outdoor labor, and with the cheapness of labor itself, it will undoubtedly result in the development of a very extensive industry.

The granitic rocks have been especially studied by Mr. Watson, who worked almost exclusively on the granites and gneisses, with incidental reference to the associated eruptives, the diorites, diabases and gabbros. In connection with the field work on these granitic rocks, he was ably assisted by Mr. Laney, who, however, devoted the larger part of his time to the marbles, limestones, sandstones, serpentine and road materials.

Dr. Merrill's guiding hand is plainly seen in the character of the work and its form of presentation. There were but few tests made to ascertain resistance to crushing, shearing, elasticity, or absorption, chiefly because the report does not pretend to be either exhaustive or final, but has been published to call attention to the deposits of stone, especially those of known economic importance, and to indicate how these can be opened and operated profitably. No chemical analyses were attempted, nor were they for the most part considered essential

for the present work, as Dr. Merrill still adheres to his opinion that more can be learned from an examination in the field than through all known laboratory tests taken together. There are a number of chemical analyses given throughout the report, which have been taken, however, from previous reports of the Survey.

The volume is divided into nine chapters, with a short appendix on Stones for Road Building. In Chapter I, which is entitled Preliminary Generalities, the essential qualities of building stones are thoroughly discussed, attention being called to the influence that color has on the market value of a stone; the ease or difficulty with which a stone can be worked, and the location of the deposit with respect to transportation facilities. The surface features of the State are considered, and it is shown that the geological formations which are capable of yielding desirable stone for structural purposes or ornamentation traverse the State in northeast and southwest directions. Beginning at the western margin of the coastal plain, there is found extending northeast from Raleigh a broad belt of gneissic rocks, succeeded on the west by one of brown sandstone, and this in order by belts of schist, granites and gneisses to the State line, the last-mentioned belt carrying in Cherokee, Graham, and Swain counties a narrow belt of marble. Within these areas there are numerous minor exceptions to the regular order mentioned above. The geographic position of the State is considered with reference to other than local markets, and it is clearly shown that North Carolina is near the center of an area containing hundreds of large and prosperous cities and towns which will afford a market for a much larger amount of building stones than it is now supplying, which should result in the development of the quarry industry on a much larger scale and without any danger whatever of ruinous competition.

Chapters II, IV, and VI take up in detail the building and decorative stones roughly classified as follows: (1) The crystalline siliceous rocks, including the granites, gneisses and diabases, or trap-rocks; (2) the calcareous rocks, including all limestones and dolomites, both the crystalline and compact common varieties; and (3) the fragmental or elastic rocks, including the sandstone and clay slates.

The granites and other crystalline rocks result either as erupted molten matter from the earth's interior or from the metamorphism of siliceous sediments. Those of the second group originate mainly as

deposits of calcareous mud from the breaking up of shells, corals, and the remains of other marine animals on an old sea bottom. Those of the third group result from the breaking up of older rocks, and the accumulation on the bottom of lakes and seas of the resultant sand, clay, or mud in beds of varying thickness, to be subsequently hardened into stone.

"The essential difference between a marble and a compact limestone, like those of Ohio or Kansas, is that the first has undergone, through the combined action of heat and pressure, just the right degree of change, or metamorphism as it is technically called, to develop in it crystallization and color; the essential difference between a brick or fire-clay and a cleavable slate suitable for roofing is, as explained elsewhere, that the first named still retains its plastic condition as it was laid down in the form of fine silt on a sea bottom, while the slate has by geological agencies, by actual movements of the earth's crust, been so squeezed and compressed as to lose all resemblance to its former self, and become the cleavable article of commerce we now find it.

"These processes of change, as noted above, are dependent very largely upon the actual movements, warpings and foldings, as one might say, of the earth's crust and the heat and chemical action which is thereby generated, and since these movements take place only with extreme slowness, whole geologic ages being occupied in their inception and completion, it follows as a matter of course that these metamorphic rocks, these gneisses, marbles and roofing slates, are found only among the older rocks and only in those portions of the country where this crust has been warped, compressed, and folded as in the process of mountain making."

Thus, one will find these rocks in their best development in those regions bordering along more or less extensive mountain ranges.

GRANITE AND OTHER CRYSTALLINE ROCKS.

The area of the State containing rocks of the first class is very extensive, and includes the three larger physiographic provinces of the State, namely, the Coastal Plain, the Piedmont Plateau, and the Appalachian Mountain; but the greater part of the granites and other crystalline rocks of economic importance are included in the Piedmont Plateau region. Along the inner margin of the coastal

plain region there are a number of small workable areas of granite of excellent quality; but in the mountain region the large granitic areas are usually schistose in structure and are not very desirable for the higher grades of work in which granites are used. These crystalline rocks are discussed in groups:

I. The Coastal Plain Region. This area includes Wilson, Edgecombe, Nash, Anson, and Richmond counties. In this region the areas capable of producing workable granite either lie close to or are crossed by the principal lines of railroad in the eastern part of North Carolina, rendering them easily accessible and providing ample facilities for transportation of the stone. The outcrops are usually large and are so located as to offer advantageous quarry sites. They are all biotite granites, showing a considerable range of variation in color and texture, from light gray to pink, with occasionally a mixed yellowish and pink appearance. No systematic quarrying has as yet been undertaken, and all that has been quarried has been used locally.

II. The Piedmont Plateau Region. 1. The Northeastern Carolina Granite Belt, including Wake, Franklin, Vance, Granville, and Warren counties. In this belt extensive workable areas of different grades of granite are found suited for all classes of work in which granite is used, except for the better grades of monumental work. Systematic quarrying, however, has been limited, principally to areas in and around Raleigh, Wake County, and at and near Greystone and Middleburgh, Vance County. These quarries have been operated quite extensively, furnishing stone to eastern Virginia and Carolina, principally in the form of blocks and curbing for street purposes; and for general building purposes. Throughout this belt the granites show but little variation in mineral composition, and, with one exception, they are biotite-granites. Minerals, such as free sulphides and iron oxides, which are a source of discoloration to stone on exposure, are practically absent from the granites of this belt.

2. The Carolina Metamorphic Slate and Volcanic Belt, including Orange, Durham, and Chatham counties: The country rocks of this belt comprise argillaceous, sericitic and chloritic metamorphosed slates and crystalline schists; sedimentary pre-Juratrias slates and ancient volcanic rhyolites, quartz-porphyrries, and pyro-clastic breccias that are often sheared and altered andesites. Rocks of granitic composition have as yet only been noted in Orange County, and they

are of doubtful commercial value except for railroad ballast and road purposes.

3. The Carolina Igneous Belt (The Main Granite Belt), including Mecklenburg, Gaston, Cabarrus, Iredell, Rowan, Davidson, Davie, Forsyth, Guilford, and Alamance counties. In this belt granite is one of the principal and most wide-spread rocks, and in each of the ten counties included in the belt extensive areas of granite are exposed. Outcrops of firm and hard moderately fresh granites are not uncommon, and, as a rule, the exposures are large enough to admit of the opening of large quarries without much stripping. The stone is usually well suited to the many purposes for which granite is used, and the belt is traversed in nearly all directions by lines of railroads which offer ample facilities for transportation. Notwithstanding these conditions, only a limited amount of quarrying has been done in these counties, with the exception of Rowan, where a systematic quarrying has been developed in a large scale on the Dunns Mountain granite ridge.

There are two distinct phases of the granite developed, an even-granular or normal and a porphyritic granite, both of which have wide distribution within the limits of the belt, and, with one exception, represent different phases of the same rock mass, the porphyritic texture grading into the even-granular. With hardly an exception the granites are mica (biotite) bearing, and they vary in color from nearly white, through the lighter to the darker shades of gray. In several places over Dunns Mountain a beautiful shade of pink granite is quarried. This stone has attracted a great deal of attention, and is much admired as a decorative stone.

4. The Western Piedmont and Granite Belt, including Surry, Wilkes, Alleghany, Alexander, and Cleveland counties. In this belt the massive granites are less abundantly distributed than over other parts of the granitic areas. They are all biotite-bearing, usually of light color and of medium texture. No injurious minerals are, as a rule, observed, the rocks possessing marked strength and durability, and are very desirable granites for certain grades of work. Mount Airy, Surry County, one of the principal localities in this belt yielding rock of this type, constitutes the largest quarrying center in the State. The demand for this stone is rapidly increasing, and wherever used has given entire satisfaction both as regards color and durability.

III. The Appalachian Mountain Region, comprising McDowell, Buncombe, Henderson, Madison, Haywood, Jackson, Macon, Transylvania, Swain, Mitchell, Caldwell, Watauga, and Ashe counties.

No systematic quarrying has as yet been undertaken at any point in this mountain region, but numerous small openings have been made in exposures of the rock in many places, the stone being used entirely for local purposes. The larger amount of the rock quarried has been used for ballast and road purposes. Transportation is the serious difficulty confronting the quarrying of the mountain granite for building purposes, except for local use.

The report shows that North Carolina is well supplied with granite deposits that are easily accessible and are of a quality that will permit of their being used for all grades of work.

Some of the rocks included under the head of the crystalline rocks are of especial interest and are mentioned more in detail.

Orbicular Gabbro-Diorite.—The orbicular gabbro-diorite is found on the Hairston plantation, Davie County, 10 miles west of Lexington and one mile west of Oaks Ferry. It occurs in high boulders, occupying a low indistinct ridge, which culminates in a peak or knoll about 30 feet above the surrounding plain. This is the only point where the orbicular rock outcrops prominently, but it can be traced in a southwest direction by means of residual decay for a distance of one-half to three-quarters of a mile in length and of several hundred yards in width. The orbicular rock undoubtedly occurs in the form of a typical dike, penetrating the porphyritic granite, and is parallel to and probably of the same age as some large massive unaltered diabase dikes in the vicinity which are intersecting the same rock.

This rock presents two distinct and strongly contrasted phases, one the pronounced orbicular and the other a granitic. Around the knoll referred to, the rocks show the typical orbicular texture, with the well-rounded spheres varying in width from one-eighth to one inch and sometimes two inches in diameter. Some distance from the knoll the rock assumes a granitic texture, but is composed of the same minerals. Mineralogically, this rock is composed principally of a basic plagioclase feldspar, showing, as a rule, but slight polysynthetic twinning, uraltic hornblende, and diallage. Besides these, titanite, apatite, magnetite and zircon occur as accessory minerals, and quartz, muscovite, calcite and zoisite as secondary minerals.

In color the rock is dark, with a greenish tinge due to the dark green hornblende. It has a pronounced mottled appearance produced by the nearly black green nodules of hornblende in a groundmass of the intensely white plagioclase feldspar. The contrast is very pleasing, and it is brought out much more prominently in the cut and polished surface. The spheres usually exhibit a fibrous radiating structure from a common center outward. In some instances a small fragment of feldspar, quartz, or pyrite has been the nucleus about which the spheres of the hornblende have been formed. The concentric structure which is usually observed in orbicular rocks is not at all pronounced in the North Carolina rock; and where the spheres of orbicular granite and diorite heretofore described are composed usually of a number of minerals, the North Carolina rock is only composed of one, the dark-green hornblende.

As a decorative or ornamental stone, this unique stone should find very great favor. It works easily and well, as is shown by a polished column and sphere that are in the State Museum at Raleigh. That it wears well is demonstrated by the fact that some of this stone quarried prior to the Civil War and used for gate-posts and steps to the house on the Peter Hairston property do not show any signs of decay. This deposit is being developed by the Consolidated Granite Company of Winston-Salem, and already many inquiries have been received regarding it.

Quartz-Porphry (Leopardite).—Intersecting the biotite-granite at Belmont Springs, $11\frac{1}{2}$ to $13\frac{3}{4}$ miles east of Charlotte, Mecklenburg County, is a dike of quartz-porphry about one-half mile long, whose width nowhere exceeds 25 feet and which has been most appropriately named leopardite. It is a dense, hard, tough and compact cryptocrystalline rock, which breaks with a conchoidal fracture. The fresh rock is nearly pure white, tinged in places a very faint greenish, and penetrated by long parallel streaks or pencils of a dead black color. If it is broken at right angles to these streaks the surface is dotted with rounded irregular black spots, varying from pin-heads up to half an inch in diameter. When the rock is broken or cut parallel with the direction of the pencils the surface is streaked with long irregular black lines, which are sometimes approximately parallel and at others assume a dendritic or fern-like appearance. These black streaks or pencils are not regularly distributed throughout the quartz-

porphyry, but in some areas they are entirely absent, while in others they are crowded very closely together.

Mineralogically, the rock is composed essentially of feldspar, both potash and plagioclase varieties, with a smaller amount of quartz, which forms minute irregular interlocking grains. Considerable of it is interwoven with the feldspar in micrographic structure, forming more or less rounded disk-like areas. The black streaks or pencils are composed of oxides of manganese and iron and are supposed to represent the percolation of manganese and iron solutions through the rock.

The rock is susceptible of an excellent polish and could be used with splendid effect in inlaid work. On account, however, of its exceeding hardness and toughness and absence of any definite rift, it will be a rather expensive stone to quarry. This rock is also being developed by the Consolidated Granite Company of Winston-Salem.

Unakite.—In Madison County, about 5 miles southwest of Hot Springs, there is an irregular area of granite containing epidote as a characterizing mineral. The main mass of this rock is described as a dark pink and green epidote-biotite-granite of coarse texture and somewhat schistose structure varying from a typical schistose granite in which the quartz is present in the usual amount to a nearly quartz-less rock of the same color and texture.

Penetrating this granite probably in the form of narrow veins is the unique and beautiful variety of granite known as unakite. This rock is composed of yellow-green epidote, dull pink or red feldspar and quartz. The unakite is not uniform in color and composition, but shows pronounced gradations into a highly feldspathic rock of pink color on the one hand and an epidote rock of a yellow-green color on the other. Usually in the veins the normal unakite, which is a coarse, massive rock of even texture, occupies the middle portion of the vein and graduates toward the enclosing gneiss either into the feldspathic or epidotic rock or both.

Under the microscope the unakite is shown to be composed of the usual granitic minerals, such as orthoclase, quartz, occasional biotite, zircon, apatite, rutile, magnetite and a few small grains of pyrite, with the secondary minerals epidote, chlorite, kaolin and a green mica.

One of the best exposures of the unakite in its relation to the other granitic rock is along Roaring Fork and a short distance above its

entrance into Meadow Fork. The commercial value of the rock would be for decorative or ornamental purposes, but at the present time it has not been developed sufficiently to determine what quantity of this rock can be obtained commercially.

In Chapter III there is a short description of the dikes and veins penetrating the crystalline rocks previously described, which includes, beginning with the most acid, true quartz veins, pegmatite, aplite and granite dikes of normal composition and texture; and abundant dikes of basic igneous rocks, of which diabase and diorite are the most common types.

LIMESTONE AND MARBLE.

Chapter IV treats of the calcareous rocks, limestones and marbles, taking up in detail their varieties, structure, weathering qualities, uses, and geographical distribution. The marble localities are confined to Cherokee, Swain, McDowell, and Mitchell counties. The only ones that have been developed commercially are those in Cherokee County. The marble of Mitchell County is perhaps worthy of more detailed notice on account of its occurrence and quality.

White Marble from Mitchell County.—This marble was first exposed in a railroad cut on the north bank of North Toe River, near the mouth of Sink Hole Creek, about $3\frac{1}{2}$ miles above Toe Cane Station. The marble is exposed in a bed about 60 feet thick interbedded with typical mica-schist, is exceptionally pure and of very uniform texture. As far as can be judged from the exposure of the blocks that are blasted out, it is remarkably free from joints. It has a beautiful pure white color and takes a good polish. It can be traced northeastward from the outcrop at the railroad for about a mile and is favorably located for quarrying, being on a mountain-side about 100 feet above the valley, thus affording natural drainage and space for disposal of waste material. Considering the location of this marble and its texture, purity and color, it offers a very favorable commercial quarry proposition. One peculiar feature of this marble deposit is the occurrence of a large pegmatitic vein in the midst of the marble.

The limestone areas are rather scarce throughout North Carolina and in no place are they of sufficient magnitude to be of any large commercial importance either for building purposes or for burning into lime. In a few localities a small amount of the stone is used

for road purposes or burned into lime for local use. In Buncombe County, about 2 miles north of Fletcher, two kilns having a capacity of 700 bushels per day have been erected for burning a limestone that is of a peculiarly fine-grained structure, containing little or no impurities, the analyses giving 95.32 per cent calcium carbonate. These kilns are operated by the Blue Ridge Lime Company.

The Serpentine and Verdantique Marbles are described in Chapter V. They are at the present time of no commercial importance, and they have been described in detail in a previous report of the North Carolina Geological Survey on Corundum and the Peridotites of Western North Carolina.

The Sandstones and Quartzites, which are taken up in Chapter VI, are discussed more from a commercial than a scientific standpoint. Although in previous years there has been considerable quarrying of the sandstone from Moore County, in recent years the industry has come nearly to a standstill. This, however, has not been on account of the quality of the sandstone as much as transportation difficulties.

The dikes penetrating the sandstones are taken up in Chapter VII, which contains tables showing their distribution and their relation to the jointing of the sandstone.

Chapters VIII and IX relate to the quarrying, working and weathering of building stones. One interesting method of quarrying building stones that is especially mentioned is that used by the North Carolina Granite Corporation at its Mt. Airy quarries, which is described as follows:

"In the center of the sheet or area to be lifted a drill-hole 2 to 3 inches in diameter is sunk 6 to 8 feet in depth, depending on the greatest thickness of stone required, and the operation is continued by the discharge of successive small amounts of powder similarly as described under the method of quarrying by using water* until the crevice extends a distance of 75 feet, or more from the hole in all directions. A pipe is then cemented into the hole and connected by means of a globe valve to an air-pipe line from an air compressor. Compressed air at 70 to 80 pounds pressure is gradually admitted and the cleavage rapidly extended until it comes out upon the hillside in a thin edge. A sheet of several

* After being drilled, the hole is fired by a succession of light blasts, using in the first charge about a handful of blasting powder. The operation is begun by discharging about a quarter of a pound of dynamite in the bottom of the hole. This small charge of dynamite pulverizes the stone slightly at the bottom of the hole and forms a small chamber. The tamping is then cleaned out by the hole, which is recharged in the same manner, this time, however, using about a handful of powder. The recharging of the hole is continued with small charges of powder until a small seam has been started at the bottom of the hole extending parallel with the surface. This is found out by using a small steel rod bent at the lower end and sharpened to a point and passing it up and down the hole until the crack is located. After the crack has once been started, the use of light charges of powder is continued, increasing the charges gradually as the seam is found to extend in all directions from the lift hole until the crevice extends a distance of 75 feet or more from the hole.

acres in extent may be raised in this manner, affording a bed plane approximately horizontal, to which the quarrymen can work, thus securing stone of any required thickness. The first time compressed air was used a pressure of 80 pounds was admitted into the cavity which had previously been extended to a distance of 100 feet from the lift-hole. The power of the air, however, was too great for the easily-splitting stone and the cleavage turned abruptly to the surface. In the next hole, however, the compressed air was admitted very gradually and the stone could soon be heard cracking in all directions, and in about half an hour the cleavage came to the surface of the hillside as a thin edge some 225 feet from the lift-hole. To extend the cleavage by means of powder for a hundred feet would require from 6 to 12 days, and with water from 3 to 5 hours, while with the compressed air the larger area was split in half an hour."

Appended to the volume is a short description of stone found throughout the State that is suitable for road building, together with a table showing the results of tests made on certain stones suitable for use in road building.

Although this volume deals especially with the economic and commercial phases of the building stones of North Carolina, making it particularly interesting and valuable to contractors, builders and dealers in building stones; yet there is sufficient detailed scientific work included to make it of considerable interest and value to the student of North Carolina geology.

PRODUCTION OF BUILDING STONES.

In 1905 the total value of the production of all kinds of stone in North Carolina was \$597,922. As compared with \$312,576, the value of the 1904 production, this is an increase of \$285,346.

There is given in the table below the value of the production of the various stones quarried in 1900 to 1905:

PRODUCTION OF BUILDING STONES IN NORTH CAROLINA, 1900-1905.

YEAR.	GRANITE.	SANDSTONE.	MARBLE AND LIMESTONE.	TOTAL VALUE.
	Value.	Value.	Value.	
1900-----	\$ 257,962	\$ 27,210	\$ *	\$ 285,172
1901-----	264,906	11,682	8,357	284,945
1902-----	338,749	4,825	23,153	366,727
1903-----	334,357	600	25,365	360,322
1904-----	292,439	250	19,887	312,576
1905-----	564,425	4,482	29,015	597,922

* Statistics not collected for 1900.

PRODUCTION OF GRANITE.

There was a most gratifying increase in the production of granite during 1905 as compared with that of any previous year. This is due to the more extensive advertising of North Carolina granite and its favorable reception in new markets. During 1905 the total value of all the granite produced was \$564,425, which, compared with the value, \$292,439, was an increase of \$271,986. Although this increase is nearly double that of the previous year, it still does not begin to represent what the granite industry of the State should attain. Next year will undoubtedly see a still further increase in the value of the granite production. The number of operators quarrying the granite during 1905 was 23, an increase of 7 over the number of 1904, and these worked 27 different quarries in the following 12 counties, given in the order of the importance of their productions: Surry, Rowan, Polk, Warren, McDowell, Buncombe, Orange, Henderson, Vance, Davie, Gaston, and Cabarrus. Rockingham, which produced a considerable amount of granite in 1904, used entirely for railroad ballast, did not make a production in 1905. Three new counties, however, are added to the list of those producing granite, namely, Warren, Davie, and Cabarrus. The production from Cabarrus was entirely for railroad ballast and was represented by the same company that was working in Rockingham during 1904, producing ballast for the Southern Railway. The new operator in Warren County is the Wise Granite Company of Wise, who produced granite that was used for a great variety of purposes, including rough and dressed building and monumental stone, paving blocks and curbing and road macadam. Considering the character and extent of the granite deposits of Warren County, this will probably be but the beginning of a granite production in this county which will increase from year to year.

One-half of the granite produced in the State during 1905 was used for building and monumental purposes, the value being \$312,362. This is greater than the value of the total production of granite in 1904, and is the best evidence of the great increase in the granite industry, and indicates that a better quality of granite is being quarried and more care and attention is given to methods of quarrying. It is the strongest evidence of the real value of the granite industry to the State and what can be accomplished by push and energy. This

value is over 4 times the value of the granite used for the same purposes in 1904, and is approximately twice as great as the largest value previously reported for granite used for this purpose, which was the production of 1903, when the value was \$167,639. There was a slight increase in the value of the granite used for road-making, railroad ballast, etc., the value of the 1905 production being \$118,470 as compared with \$93,296, the value of the 1904 production. There is given in the following table the value and uses of the granite quarried from 1902 to 1905 inclusive:

USES OF GRANITE PRODUCED IN NORTH CAROLINA IN 1901-1905.

USES.	1901.	1902.	1903.	1904.	1905.
Building and monumental purposes	\$ 108,574	\$ 167,639	\$ 127,486	\$ 75,632	\$ 312,362
Paving blocks	10,662	6,986	30,780	15,907	48,234
Curbing and flagging	56,245	82,615	68,099	101,632	74,807
Crushed stone for road-making, railroad ballast, etc.	89,425	77,759	102,524	93,296	118,470
Other purposes	-----	3,750	5,468	6,072	11,052
Total value	264,906	338,749	334,357	292,439	564,425

There is given in the following table the value of the granite product from 1897 to 1905 inclusive, which shows most strikingly the growth of this industry in the State. In nine years it has increased nearly tenfold:

PRODUCTION OF GRANITE IN NORTH
CAROLINA, 1897 TO 1905.

YEAR.	VALUE.
1897	\$ 59,236
1898	79,969
1899	225,544
1900	257,962
1901	264,906
1902	338,749
1903	334,357
1904	292,439
1905	564,425

PRODUCTION OF SANDSTONE.

The sandstone industry has not yet assumed any large proportion and for the two years previous has been nearly at a standstill. The sandstone deposits are rather extensive, as described in the report

referred to above, and some of them are capable of being developed into quarries that would furnish a good building stone. There was only one quarry worked in 1905, the Carrington-Gonella quarry, near Sanford, Moore County. A deposit that is rather favorably located for quarrying and gives indications of producing a sandstone suitable for building purposes is on the property of Mr. Benehan Cameron of Raleigh, which is located at Farintosh, Durham County. If a quarry were developed at this locality it would have good railroad transportation.

During 1905 the production of sandstone amounted in value to \$4,482. The previous year it was only valued at \$250 and in 1903 \$600. One encouraging feature of the 1905 production is that nearly all of it was dressed stone for building purposes. In the table below is given the value of the production of sandstone for the years 1897 to 1905 inclusive, and will illustrate how small this industry is in the State:

PRODUCTION OF SANDSTONE IN NORTH
CAROLINA, 1897 TO 1905.

YEAR.	VALUE.
1897	\$11,500
1898	9,100
1899	10,300
1900	27,210
1901	11,682
1902	4,825
1903	600
1904	250
1905	4,482

PRODUCTION OF MARBLE AND OTHER FORMS OF LIMESTONE.

Notwithstanding the demand that there is in North Carolina for lime, there is still but a very small amount produced in this State, and nearly all is imported. One of the main reasons for this is the excessive railroad rates on lime shipped from North Carolina kilns. The Blue Ridge Lime Company, who were operating kilns near Fletcher during the past year, have doubled the capacity of their kilns and should very largely increase their production of lime for the coming year. During 1905 the total amount of lime produced amounted to 22,800 bushels valued at \$7,660 and was obtained from

Henderson and Buncombe counties. The balance of the production of lime rock in the State for 1905 was used for road macadam and amounted to 17,084 tons valued at \$21,355, and was all obtained from New Hanover County. There was no marble at all produced in the State during 1905. The total production of lime rock was valued at \$29,015, and is the greatest value reported for any year since the records have been collected.

In the following table is given the value of the production of limestone and marble from 1901 to 1905 inclusive:

PRODUCTION OF MARBLE AND OTHER
FORMS OF LIMESTONE, 1901-1905.

YEAR.	VALUE.
1901	\$ 8,357
1902	23,153
1903	25,365
1904	19,887
1905	29,015

SLATE.

There was no production of slate in North Carolina during 1905.

SAND AND GRAVEL.

There is an enormous quantity of sand and gravel produced each year and utilized for various purposes. The value of a considerable proportion of this sand and gravel amounts to only the time and labor required to dig and haul the material to the point of consumption, and it is practically impossible to estimate or give any quantity or value for a great deal of these materials that are utilized each year. Thus, large quantities that are used in railway, highway, and sidewalk construction have not been estimated. While most of this has a value of from 5 to 15 cents per ton, it has been impossible thus far to obtain any adequate idea of the quantity of the product utilized each year. The general uses of sand outside of those already enumerated are for flux in copper smelting; for fire-proofing; molding sand, which varies considerable in value, as in making fine castings and heavy castings it is necessary to use a particular quality of sand, while for ordinary castings a more ordinary sand can be used; glass-

sand used in the manufacture of glass, which must be a purer sand than that used for any other purpose; building sand used for mortar, plaster and concrete structure; fire-engine and furnace sands, which are particular qualities of sand adapted for these particular purposes; a grinding-sand, which is used for cutting and grinding stone, glass, etc.; sand used in the manufacture of brick, pottery, sanitary ware, etc.; and sand used in sand-blast machines. Gravel is used in large quantities as rough material for ballast on railways and highways and in concrete work. Of the above uses of sand and gravel, statistics have only been collected during the past year for that used in molding. As far as is known, there is no sand produced in North Carolina for use in the manufacture of glass; but for all the other purposes enumerated above there is more or less sand produced in North Carolina.

When it is considered that there are approximately 150,000,000 brick made and used in North Carolina each year besides those imported into the State, which run up well into the millions, one can obtain some idea of the amount of sand that has been used in making the mortar for laying this number of brick. Estimating this amount of sand at one ton per thousand brick and the number of brick used in North Carolina at 200,000,000, it would make 200,000 tons of sand. Besides this large amount of sand there is an enormous quantity used in the manufacture of plaster used in the large number of buildings that have been constructed during the past year.

The figures obtained for the production of molding sand were 859 tons valued at \$547. This does not represent all of the sand used for this purpose, as a considerable amount has been used by foundrymen, which has been obtained close by their shops and no special record kept of the quantity or of its cost.

SAND-LIME BRICK.

The manufacture of sand-lime brick is becoming an industry of some importance in North Carolina, and it offers possibilities of a much greater growth. While as yet the production of these brick in the State is not very large, yet it has increased during the past three years and the brick command a considerably higher price than the clay-brick. As this industry is comparatively new in North Carolina and as it offers possibilities for profitable investment at a

number of localities throughout the State, a short description of sand-lime brick, their manufacture, etc., may be of interest.

A sand-lime brick consists of sand particles that are cemented together by calcium silicate, or calcium magnesium silicate or calcium hydro-silicate. This cementing material is obtained by the action of steam under pressure upon either a high calcium lime or a magnesium lime which has been previously hydrated. The sand and lime in certain definite proportions are mixed together and then sufficient water added to hydrate the lime, when they are molded and put in a furnace and subjected to steam under pressure. There is a definite chemical reaction that takes place, and the calcium silicate or calcium magnesium silicate or calcium hydro-silicate that is formed is a definite chemical compound and forms a strong binding material between the particles or grains of quartz.

As stated by Mr. S. P. Peppel:*

"The sand-lime brick of to-day is the natural outcome of the improvements made in the old mortar brick, which has been known for years. This mortar brick was at first never more than a molded mixture of lime and sand mortar which was allowed to harden in the air. Later, carbon dioxide was supplied artificially in large quantities so as to hasten the process of hardening. The next improvement was the introduction of carbon dioxide under pressure. Following this use of carbon dioxide under pressure and in the presence of moisture, mild heat was applied. This last process is still used to some extent. But the most marked advance was the one which applied an entirely new principle to the hardening of sand and lime mixtures, and produced what is known to-day as sand-lime brick, an entirely different body from that of the mortar brick. This was the invention of Doctor Michaelis. Some twenty-five or thirty years ago he patented a process for the hardening of mixtures of lime and sand by steam under pressure, thereby introducing into the sand-lime brick an entirely different bond from that in the mortar brick, which in reality has no bond, but only a hardened or solidified filler.

"Doctor Michaelis allowed this patent to lapse without commercial development, and in consequence the fundamental principle on which the manufacture of sand-lime brick is based is now public property, and all patents must be on details of manufacture or combinations of such details. The term "mortar brick" should be confined to the brick which is hardened by the solidification of the lime through the formation of carbonates, and should not be confounded with the sand-lime brick, which is a different product and has materially different properties."

There are a number of processes that have been introduced for the manufacture of sand-lime brick, some of which have been patented. They all, however, involve the same fundamental principle, the forma-

* U. S. Geological Survey Mineral Resources, 1903, p. 866.

tion of a calcium silicate bond, and the value of each depends on the economy with which they can be operated.

The following description of the manufacture of sand-lime brick and materials used is drawn largely from the article referred to above. The raw materials used in the manufacture of these brick consist of a comparatively pure quartz sand or granular silicate and a comparatively pure calcium lime or magnesium lime, the former giving the better results. While most any sand could be adapted and would give a hard brick at the time of its manufacture, yet if the sand contains a good many impurities, the brick will yield more readily to weathering than one made with the pure sand. There are a number of localities in Cherokee, Swain, Transylvania, Henderson, Buncombe, Madison, Mitchell, McDowell, Catawba, Lincoln, Gaston, Craven, Beaufort, Onslow, Duplin, Pender, Brunswick and New Hanover counties that contain calcareous rocks, as the limestone, marbles, shell-rock, etc., that are in close proximity to sand-beds, and many of these offer favorable opportunities for the manufacture of sand-lime brick.

It is very essential in the manufacture of these brick that the raw material be properly prepared, for if the lime is not evenly distributed throughout the mixture the strength of the brick will be lessened, and if the material is not thoroughly mixed and the lime thoroughly slaked masses of lime may remain sufficient to cause rupture by expansion during the process of hardening, due to the complete hydration of the unslaked lime by the steam.

It is also necessary to select the raw materials, sand and lime, carefully, if the best results are to be obtained. Sand varies widely in its texture and also in the amount of other minerals constituting impurities that are associated with it. Sand may be very coarse or very fine and all degrees of coarseness between the two. It may contain as impurities clay, mica and feldspar (three silicates) and limonite, a hydrous ferric oxide. Perhaps the most common and widespread impurity of sand is clay. A sand containing up to 6 or 8 per cent of clay can be used without any serious disadvantage. Any larger percentage of clay than this will necessitate the use of a larger percentage of lime to obtain the same quality of brick, and with too high a percentage of clay, the resultant brick will not be as strong and will be apt to disintegrate when acted upon by age and water. Feldspar up to 10 per cent does not seem to have any seriously inju-

rious effect upon the brick. The limonite, iron oxide, does not apparently affect the strength of the brick, but will determine its color, this oxide reacting to give the brick some shade of red color.

Experiments seem to show that for the rapid and economical production of sand-lime brick a certain proportion of very fine sand should be used, and that the stronger brick are obtained by using a mixture of coarse and fine sand in the proportion of 3 parts of coarse to 2 parts of fine to 2 parts of coarse and 1 part of fine sand. The finer the material that is used the more difficult it will be to mix the materials together so as to get a coating or film over each particle of sand; but, on the other hand, the resultant brick will be more compact and have a neater appearance. A sharp sand will give better results than sand with round corners, although sand-lime brick made of this latter sand will have sufficient strength to answer all requirements, especially if some fine material is introduced prior to manufacture. A coarse sand would represent one from 20 to 80 mesh and fine sand from 150 up.

Most any lime can be used in the manufacture of sand-lime brick, but experiments seem to show that a calcium lime will give a stronger brick than a magnesium lime. It is essential for the best results that the lime should not be badly air-slaked, and in determining what lime to use, consideration must be given to the fact that calcium lime air-slakes much more readily and rapidly than magnesium lime. There is usually used from 5 to 10 per cent of lime, according to the quality and type of the lime as well as its condition and proportion. The calcium lime will slake more rapidly in preparing it for manufacture of the brick than the magnesium lime, and thus requires much less time and care to insure a thoroughly slaked product, which is essential to the best success in the manufacture of sand-lime brick. There are two distinct classes of processes for slaking the lime, one in which lime is slaked to putty with a slight excess of water and then allowed to stand for some time. By this method the best possible product is obtained, and this may be used either in the condition of a putty or after being dried and ground to a flocculent powder. The other method is cheaper and easier of operation and consists of slaking the lime to a dry powder, either by the addition of sufficient water during the agitation of the lime to hydrate as completely as possible and still to leave a dry powder, or by slaking with the aid of steam in an enclosed vessel. Most of the lime is slaked prior to being mixed

with the sand, and probably the simplest and surest way of manufacture is by taking the dry sand and a thoroughly slaked dry calcium hydrate (slaked lime) and mixing them thoroughly in the desired proportions before any water is added.

The mixing process should be carried out very carefully and thoroughly in order that the lime may be distributed throughout the entire mass, and in this process the presence of the fine sand seems to assist it materially. There are a great many mixing machines in use and all those of the intermittent type yield a thorough mixture, provided it is retained sufficiently long in the machine. The amount of water introduced should only be just enough to yield a mass which will just cohere together when squeezed so as to be capable of retaining its shape after passing through the press so as to be transferred to the steam or hardening cylinders.

The machinery needed for a sand-lime plant consists of—

Power and transmission;

Lime-preparing machinery;

Mixing apparatus;

Presses;

Hardening cylinders;

Conveyors;

Tracks and trucks.

The power and transmission machinery does not differ materially from that used in other industries.

The lime-preparing machinery has already been incidentally mentioned. When the quicklime processes are used the only preparing machinery necessary is such as will reduce the lump-lime to fine powder. This usually consists of a small crusher and a grinder or pulverizer. This machinery should be so constructed or so located as to confine the dust either to the machine itself or to a small compartment. For plants with sufficient capacity the best arrangement is to have a pulverizer with an air separator.

In plants which hydrate their lime prior to mixing with the sand, the machinery used is some sort of a crusher or breaker, which breaks the lime down to small lumps, varying in size from that of a pea to about $\frac{3}{4}$ -inch in diameter. This breaker is not always used.

Dry hydrate slaking may be divided into two processes, open slaking and inclosed slaking. Open slaking is accomplished in several ways. In the most simple form of open slaking, floor space or bins,

usually constructed of concrete, are used, and sufficient water is added to the lump-lime, so that after it has stood a few days and dried off, it is for the most part slaked. The resultant product is then screened, and the fine material used, and the remainder thrown back for re-slaking. There is a patent process of the same type in which the lime is wet, and then covered with a coating of previously hydrated lime which serves as a protection from the action of the air and retains a good deal of the heat and steam generated. Open slaking machinery properly consists of mixing machinery, which is not covered. There are a number of machines now used for this purpose, some of them on the pug-mill order, and others on the wet or dry plan. Some are patented and some are not. The patents mainly apply to details of manipulation and not to the mixing machines themselves. One of the patents in this class slakes finely-ground quicklime by constant agitation with water, another slakes lime or ground lime to a putty, and then dries this product by the addition of more quicklime.

"The inclosed slaking machines are of three kinds. One kind agitates the lime in an inclosed vessel with water alone; another type not only uses water, but introduces some live or exhaust steam as well; the third kind slakes in an inclosed cylinder, and has been patented; but the patent is at present in the courts, and their decision will decide whether it is public property or not."

The mixing machinery now in use fall pretty closely within the following four types: Wet plan, pug mill, ball or tube mill and an inclosed cylinder with curved paddles or S-shaped mixing arms.

There is at the present time no press that probably gives entire satisfaction and fulfills the following requisites for a good press: Of being able to deliver regularly a pressure of from 200 to 250 tons per brick and yet not break down if by accident the pressure becomes somewhat greater; of filling the mold with great accuracy and uniformity; of having its working parts so arranged that they will be very free from contact with loose sand, which would otherwise cut them out at an alarming rate; of having the linings of its dies and molds made of the hardest material possible. There are two distinct types of presses in use, one known as the ordinary American dry pressed brick machine and other known as the German type of machine, which has a rotary table.

The hardening cylinders consist of enormous steam-tight iron or steel receptacles so constructed that cars loaded with brick can be

readily introduced into them and resembling in appearance enormous boilers or steel tubes with one entire head removable. These vary in size from $5\frac{1}{2}$ to 7 feet in diameter and from 35 to 67 feet in length.

Conveyors, tracks, trucks, etc., vary with different plants and mode of construction of same.

The estimated cost of a well-equipped sand-lime brick plant having a capacity of from 16,000 to 20,000 brick in 10 to 12 hours, independent of the site, is worth from \$20,000 to \$25,000, varying with the cost of machinery and labor and locality at which it is erected. The cost of production of the brick independent of depreciation of machinery and interest on investment varies from \$3 to \$5 per thousand, while the selling price ranges in different localities from \$8 to \$15 per thousand.

PRODUCTION.

During 1905 the production of sand-lime common brick in North Carolina amounted to 3,185,000 brick valued at \$20,953, and 660,000 front brick valued at \$8,150, making a total of 3,845,000 brick valued at \$29,103. The production of 1904 was 1,800,000 valued at \$17,500. The 1905 production was made by three producers, one each in Buncombe, Scotland, and New Hanover counties.

CLAY.

Although the production of clay products in North Carolina has constantly increased during the past few years, yet the industry does not begin to be as great as the quantity and quality of the various clays in the State would warrant. The better qualities of clays are still shipped outside the State, and there have been no new companies organized to manufacture terra-cotta, pottery or other finer grades of clay products. As has been indicated before, it is not a lack of demand for this product in the State, for large quantities of them are imported each year. The total value of all clay products manufactured in 1905 is largely in excess of that of 1904, amounting to \$1,038,430. Including the value of kaolin the total value of the clay industry in the State in 1905 was \$1,124,052.

There is a large field for investment in clay products in North Carolina, especially in the manufacture of pressed, fancy and vitrified brick; in the manufacture of earthenware, stoneware and decorative ware; and in the manufacture of porcelain, electrical insulators, etc.

KAOLIN.

Production.

During 1905 the production of kaolin in North Carolina amounted to 10,988 tons valued at \$85,622, as compared with 9,110 tons valued at \$76,670 in 1904, being an increase of 1,878 tons in quantity and of \$8,952 in value. The average value per ton of the 1905 production was \$7.79 per ton, which is a decrease of 62 cents as compared with the average value of \$8.41 per ton of the 1904 production. This production was obtained from Jackson, Swain, and Richmond counties, given in the order of the importance of their productions.

POTTERY CLAY.

Production.

The decline in the pottery industry that was noted in the report for last year continued during 1905, the value of the production being only \$13,319 as compared with \$13,900, the value of the 1904 production, a decrease of \$581. This small production was divided amongst 24 manufacturers in the following 9 counties, given in the order of the importance of their productions: Buncombe, Union, Wilkes, Lincoln, Catawba, Randolph, Chatham, Johnston, and Moore. Montgomery County, which reported a production in 1904, made no production in 1905, but Moore County was added to the list of those producing pottery. None of the 24 manufacturers produced any great amount of pottery, the largest one only producing pottery to the value of \$2,000. Of the 1905 production, \$387 was the value of red earthenware and \$12,932 the value of stoneware.

Notwithstanding the constant demand for red earthenware and stoneware and the large amount of this material that is imported, there has been no special interest aroused in this industry in the State. By utilizing better material for glazing the ware and exercising more care in the manufacture of the pottery a better and more uniform product could be put on the market, but the two essentials for the development of this industry are capital and experienced men.

There was a small amount of pottery clay sold crude in 1905, amounting to 50 tons, valued at \$25, and was obtained from Catawba County. The values of the different grades of pottery produced during 1904 and 1905 are given by counties in the following table:

VALUE OF THE POTTERY PRODUCTS OF NORTH CAROLINA BY
COUNTIES IN 1904 AND 1905.

COUNTY.	1904.			1905.		
	EARTHEN- WARE.	STONE- WARE.	TOTAL.	EARTHEN- WARE.	STONE- WARE.	TOTAL.
Buncombe -----	\$ 31	\$ 1,300	\$ 1,331	\$ 125	\$ 2,725	\$ 2,850
Catawba -----		4,450	4,450		1,930	1,930
Chatham -----		600	600		500	500
Johnston -----	50	350	400	100	150	250
Lincoln -----	15	3,970	3,985	20	2,059	2,079
Montgomery -----	50	300	350			
Moore -----					100	100
Randolph -----	150	1,040	1,190		790	790
Union -----	100	300	400	100	2,400	2,500
Wilkes -----	42	1,152	1,194	42	2,278	2,320
Total -----	438	13,462	13,900	387	12,932	13,319

FIRE-CLAY AND PIPE-CLAY.

Production.

Under the head of the production of fire-clay and pipe-clay products are included fire-brick, sewer-pipe, drain tile, fancy tile, flue linings, terra-cotta, etc., and fire-clay and pipe-clay sold crude. In 1905 the total value of all these products reported was \$111,272. This is a decrease of \$2,928 as compared with \$114,200, the value of the production of 1904. This branch of the clay industry in North Carolina has up to the past year increased rapidly since 1900, but there is plenty of room for a much greater advance to be made.

Of the 1905 production, \$8,333 was the value of 681,000 fire-brick, which were manufactured in Buncombe and Cabarrus counties. This is an increase of 518,000 brick in quantity and of \$5,633 in value as compared with 163,000 brick valued at \$2,700, the production of 1904. There was also a small amount of crude fire-clay sold in 1905 amounting to 57 tons valued at \$494. The production of terra-cotta, sewer-pipe, tiling, drain tiles, etc., during 1905 was valued at \$102,445, and was obtained from Guilford, Wake, Beaufort, Randolph, and Forsyth counties, given in the order of the importance of their productions. This is a decrease of \$8,355 in value as compared with \$110,800, the value of the 1904 production. There is given in the following table the production of fire-clay and pipe-clay products for the past 5 years and shows the decided increase in the value of this industry:

PRODUCTION OF FIRE-CLAY AND PIPE-CLAY PRODUCTS IN
NORTH CAROLINA, 1901-1905.

YEAR.	FIRE-BRICK.		SEWER- PIPE, TILE, ETC.	CRUDE CLAY.	
	QUANTITY.	VALUE.		TONS.	VALUE.
1901	55,000	\$ 550	\$ 55,745		\$ 100
1902		1,203	72,618		215
1903	407,500	5,250	100,989	231	875
1904	163,000	2,700	110,800	80	700
1905	681,000	8,333	102,445	57	494

BRICK-CLAY.

Production.

In nearly every county in North Carolina there are clay deposits suitable for the manufacture of common brick, these consisting of both residual and sedimentary clays. In some the deposits are very extensive from which excellent brick can be made. In many instances the brick-yards can be favorably located near railroad transportation, and fuel for burning the brick can usually be obtained at a very low price. Notwithstanding the advantages for brick manufacture in the State, the brick industry has not been as valuable as it should have been, and this is largely due to the lack of capital for installing machinery and also for lack of men experienced in brick manufacture. With the exception of fire-brick, the total number of brick manufactured in North Carolina during 1905 amounted to 154,885,000 valued at \$913,814. This is an increase of 9,956,150 brick in quantity and of \$97,095 in value as compared with 145,928,850 brick valued at \$816,719, the production of 1904. The average value per thousand of the 1905 production was \$5.89 as compared with \$5.54, the average value per thousand of the 1904 production, this being an increase of 35 cents per thousand. There were 59 counties from which this production was obtained, which is two more than in 1904, which in turn was five less than in 1903. These counties—Carteret, Gates, Macon, Montgomery, and Transylvania—which reported a production of brick during 1904, reported none during 1905, while Anson, Franklin, Madison, Pender, Perquimans, Stokes, and Yadkin, which made no production during 1904, became producers in 1905. Of the 1905 production there were 153,610,000 common

brick valued at \$896,289, which is an increase of 9,621,150 brick in quantity and of \$100,795 in value as compared with 143,988,850 common brick valued at \$795,494, the production of 1904. The number of pressed and fancy brick manufactured in 1905 was 875,000 valued at \$13,925; and of vitrified brick 400,000 valued at \$3,600, as compared with a production of 1,510,000 pressed brick valued at \$17,375 and 430,000 vitrified brick valued at \$3,850 in 1904. In the table below is given the quantity and value of common, pressed, vitrified, and fire brick produced during the past four years:

PRODUCTION OF COMMON, PRESSED, VITRIFIED, AND
FIRE BRICK IN 1902, 1903, 1904, AND 1905.

CHARACTER.	1902.		1903.		1904.		1905.	
	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.
Common brick----	131,618,700	\$694,827	136,822,900	\$731,802	143,988,850	\$795,494	153,610,000	\$896,289
Pressed brick----	1,833,000	10,625	766,000	8,230	1,510,000	17,375	875,000	13,925
Vitrified brick----	600,000	6,000	500,000	5,000	430,000	3,850	400,000	3,600
Fire-brick-----	120,000	1,203	407,500	5,250	163,000	2,700	681,000	8,333
Total-----	134,171,700	712,655	138,496,400	750,282	146,091,850	819,419	155,566,000	922,147

The average value per thousand received for common brick in 1905 was \$5.83, which is 38 cents greater than the average value of \$5.45 per thousand of the 1904 production. The lowest value per thousand reported as having been received for common brick during 1904 was \$4, which was received for 50,000 brick manufactured in Wake County, and the highest value per thousand was \$9, which was received for 800,000 brick from Robeson County. The brick manufactured in the extreme eastern counties bring a relatively higher value than those manufactured in any other section of the State, principally on account of the higher cost of the brick imported into these counties. The number of manufacturers engaged in making brick in 1905 was 164, which is 15 less than the number, 179, engaged in this business in 1904. One thing to be noticed in connection with the manufacture of brick in North Carolina is that the larger companies are increasing their production and there is beginning to be a falling off of the very small producers.

In the following tables the total number and value of the different varieties of brick, including fire-brick, manufactured in North Carolina are given for the years 1905 and 1904 by counties:

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA
DURING 1905, BY COUNTIES.

COUNTY.	COMMON BRICK.	VALUE.	PRESSED BRICK.	VALUE.	VITRI- FIED AND FIRE BRICK.	VALUE.
Alamance	4,275,000	\$ 27,950		\$		\$
Anson	250,000	1,500				
Beaufort	2,425,000	14,850				
Bertie	75,000	450				
Bladen	125,000	750				
Buncombe	4,340,000	26,833	55,000	725	481,000	5,683
Burke	1,240,000	6,250				
Cabarrus	8,200,000	53,200	500,000	10,000	500,000	6,250
Caldwell	3,300,000	16,500				
Catawba	3,200,000	14,750				
Chatham	300,000	1,500				
Chowan	1,100,000	7,700				
Cleveland	825,000	4,800				
Columbus	2,075,000	12,500				
Craven	8,764,000	48,765				
Cumberland	3,000,000	16,500				
Davidson	3,000,000	19,000				
Duplin	40,000	263				
Durham	9,475,000	57,063				
Edgecombe	4,975,000	29,950	120,000	1,200		
Forsyth	10,283,000	55,915				
Franklin	2,300,000	14,500				
Gaston	2,220,000	11,520				
Greene	810,000	5,420				
Guilford	8,133,000	47,799				
Halifax	4,850,000	26,950				
Harnett	100,000	700				
Haywood	550,000	3,025				
Henderson	1,000,000	5,000				
Iredell	1,200,000	7,200				
Johnston	3,515,000	22,240				
Lenoir	700,000	3,500				
Lincoln	20,000	120				
McDowell	300,000	1,800	200,000	2,000		
Madison	125,000	625				
Mecklenburg	5,000,000	27,500				
Moore	1,800,000	9,854				
Nash	1,500,000	9,000				
New Hanover	2,750,000	16,500				
Orange	550,000	2,750				
Pasquotank	2,400,000	13,600				
Pender	500,000	3,000				
Perquimans	190,000	1,330				
Pitt	1,100,000	6,950				
Randolph	2,396,000	13,183				
Robeson	2,345,000	16,888				
Rockingham	2,450,000	14,450				
Rowan	3,760,000	21,800				
Rutherford	435,000	2,556				
Scotland	300,000	1,800				
Stokes	1,000,000	7,000				
Surry	870,000	5,080				
Union	3,674,000	19,900				
Wake	4,808,000	28,559				
Washington	100,000	800				
Wayne	10,750,000	59,563				
Wilkes	1,500,000	9,000				
Wilson	6,166,000	37,000				
Yadkin	167,000	838				
Total	153,610,000	896,289	875,000	13,925	981,000	11,933

NUMBER AND VALUE OF BRICK MADE IN NORTH CAROLINA
DURING 1904, BY COUNTIES.

COUNTY.	COMMON BRICK.	VALUE.	PRESSED BRICK.	VALUE.	VITRIFIED AND FIRE BRICK.	VALUE.
Alamance	4,440,000	\$ 25,750		\$--		\$--
Beaufort	2,840,000	17,000			30,000*	300
Bertie	1,475,000	8,850				
Bladen	300,000	1,800				
Buncombe	3,575,000	18,860	100,000	1,250	153,000†	2,600
Burke	550,000	2,800				
Cabarrus	5,350,000	26,750	100,000	1,000		
Caldwell	2,200,000	8,800				
Carteret	341,000	1,850				
Catawba	1,960,000	10,045				
Chatham	151,000	708				
Chowan	1,000,000	7,000				
Cleveland	915,000	4,800				
Columbus	2,000,000	10,300				
Craven	8,639,000	47,515				
Cumberland	1,750,000	9,500				
Davidson	1,075,000	5,300	5,000	75		
Duplin	26,000	174				
Durham	3,665,000	19,625				
Edgecombe	6,075,000	36,200				
Forsyth	5,380,000	28,540				
Gaston	3,500,000	19,400				
Gates	90,000	270				
Greene	60,000	420				
Guilford	13,450,000	78,368	50,000	500	100,000*	850
Halifax	4,100,000	24,000	125,000	1,250		
Harnett	250,000	1,450				
Haywood	800,000	4,400				
Henderson	2,000,000	10,000	30,000	300	300,000*	2,700
Iredell	995,000	5,250				
Johnston	2,840,000	15,800				
Lenoir	500,000	2,000				
Lincoln	1,225,000	6,300				
McDowell	450,000	2,700	200,000	2,000		
Macon	150,000	750				
Mecklenburg	3,500,000	21,000				
Montgomery	10,000	40				
Moore	2,900,000	16,400				
Nash	1,300,000	7,800				
New Hanover	2,750,000	17,125	800,000	10,000		
Orange	1,217,000	6,628				
Pasquotank	1,900,000	10,800				
Pitt	2,200,000	13,200				
Randolph	990,000	5,266			10,000†	100
Robeson	1,805,000	10,788				
Rockingham	7,580,000	38,075	100,000	1,000		
Rowan	4,100,000	23,000				
Rutherford	1,000,000	5,700				
Scotland	500,000	3,000				
Surry	1,325,000	6,375				
Transylvania	1,225,000	750				
Union	4,879,000	24,768				
Wake	5,717,850	31,479				
Washington	300,000	2,400				
Wayne	9,000,000	49,625				
Wilkes	1,500,000	7,500				
Wilson	5,273,000	30,500				
Total	143,988,850	795,494	1,510,000	17,375	593,000	6,550

*Vitrified brick.

† Fire brick.

Of the 97 counties in North Carolina, only 59 reported any production of brick. The county producing the largest number of brick in 1905 was Wayne, whose production was 10,750,000 valued at \$59,563. Forsyth County was second with a production of 10,283,000 brick valued at \$55,915, and Cabarrus County was third with a production of 9,200,000 brick valued at \$69,450. This increased value is due to the number of fire-brick manufactured. In 1904 the first three counties were Guilford, Wayne, and Rockingham, with the following productions respectively: 13,450,000 valued at \$78,368; 9,000,000 valued at \$49,625; 7,580,000 valued at \$38,075. The county producing the smallest number of brick was Lincoln with a production of only 20,000 brick valued at \$120.

There is given in the table below the quantity and value of all the clay products produced in North Carolina from 1901 to 1905 inclusive:

VALUE OF CLAY PRODUCTIONS OF NORTH CAROLINA IN
1901, 1902, 1903, 1904, AND 1905.

	1901.		1902.		1903.	
	QUANTITY.	VALUE.	QUANTITY.	VALUE.	QUANTITY.	VALUE.
Common brick	134,441,570	\$697,861	131,611,700	\$694,827	136,822,900	\$ 731,802
Pressed brick	1,095,000	10,220	1,233,000	10,625	766,000	8,230
Vitrified brick	180,000	1,650	600,000	6,000	500,000	5,000
Fire-brick	55,000	550		1,203	407,500	5,250
Earthenware		4,490		658		612
Stoneware		17,453		13,854		13,700
Decorated ware		552				
Sewer-pipe, tile, etc.		55,745		72,618		100,989
	<i>Tons.</i>		<i>Tons.</i>		<i>Tons.</i>	
Kaolin	15,575	119,172	13,322	108,105	8,605	76,000
Fire-clay		100		215	231	875
Total value		907,793		908,105		942,458

	1904.		1905.	
	QUANTITY.	VALUE.	QUANTITY.	VALUE.
Common brick	143,988,850	\$795,494	153,610,000	\$ 896,289
Pressed brick	1,510,000	17,375	875,000	13,925
Vitrified brick	430,000	3,850	400,000	3,600
Fire-brick	163,000	2,700	681,000	8,333
Earthenware		438		387
Stoneware		13,462		12,932
Decorated ware				
Sewer-pipe, tile, etc.		110,800		102,445
	<i>Tons.</i>		<i>Tons.</i>	
Kaolin	9,110	76,670	10,988	85,622
Fire-clay	202*	761	107*	519
Total value		1,021,550		1,124,052

* Including ordinary stoneware clay sold crude.

The statistics given in this table regarding the clay production of the State do not perhaps represent the total output, for the reason that in many of the counties there are a few thousand brick made for local purposes regarding which it is extremely difficult or impossible to obtain any statistics, this being especially true where the brick are not for sale, but are used directly by those manufacturing them.

SUMMARY.

In order to compare the various mineral productions with each other and with the previous years, there is given in the following table the values of the various minerals produced in North Carolina for the years 1900 to 1905 inclusive:

THE MINERAL PRODUCTION IN NORTH CAROLINA FOR THE YEARS 1900, 1901, 1902, 1903, 1904, AND 1905.

MINERAL.	VALUE.					
	1900.	1901.	1902.	1903.	1904.	1905.
Gold -----	\$ 46,653	\$ 60,411	\$ 93,650	\$ 113,604	\$ 123,924	\$ 129,153
Silver -----	15,986	34,024	30,212	16,907	19,132	20,216
Copper -----	41,600	76,900	212,553	67,037	36,600	88,000
Iron -----	42,000	4,997	52,771	78,540	79,846	70,352
Pyrite -----	14,625	32,000				
Garnet -----	18,000	43,000	10,040	12,250	6,586	9,000
Corundum -----	36,840	48,840				
Millstones -----			1,425	902	6,500	2,652
Mica { Sheet -----	65,200	79,849	31,653	86,300	100,724	100,900
{ Scrap -----	36,262	14,200	2,919	2,400	3,410	3,375
Quartz -----		7,500	11,250	36,827	36,269	13,659
Precious stones -----	12,020	24,245	5,300	1,525	10,600	3,350
Rare minerals -----			60	270	160	
Monazite -----	48,805	59,262	64,160	58,694	79,438	107,324
Zircon -----			360	570	200	1,600
Barytes -----		22,615	44,130	21,347	33,930	21,670
Talc and pyrophyllite -----	42,000	77,974	88,962	76,984	65,483	74,940
Mineral water -----		42,167	18,795	13,085	21,902	38,755
Graphite -----		559	4,300	248	525	475
Coal -----	22,500	5,585	24,500	25,300	8,820	2,336
Stone -----	285,172	284,744	366,727	360,322	312,576	597,922
Sand and gravel -----					17,500	547
Sand-lime brick -----					76,670	29,103
Kaolin -----	62,440	119,172	108,105	76,000	85,622	85,622
Clay products -----	815,975	788,618	800,000	866,458	944,880	1,038,430
Total value -----	1,604,078	1,821,276	2,021,872	1,915,570	1,985,675	2,439,381

This table shows the general increase in North Carolina's mineral production and emphasizes particularly the increase in the value of the production of those minerals in which North Carolina excels.

The 1905 production was obtained from 78 counties as compared with 76 counties in 1904, and in the following table the value of the productions for the years 1905 and 1904 in each county is given:

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH
CAROLINA IN 1904 AND 1905.

COUNTY.	1904.			1905.		
	MINERAL PRO- DUCTION, INCLUD- ING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.	MINERAL PRO- DUCTION, INCLUD- ING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.
Alamance	\$ 24	\$ 25,750	\$ 25,774	\$ -	\$ 27,950	\$ 27,950
Alexander	150		150	600		600
Alleghany						
Anson	304		304		1,500	1,500
Ashe	175		175	830		830
Beaufort		17,500	17,500		15,250	15,250
Bertie		8,850	8,850		450	450
Bladen		1,800	1,800		750	750
Brunswick						
Buncombe	24,728	23,471	48,199	35,607	36,785	72,392
Burke	26,806	2,800	29,606	1,015	6,250	7,265
Cabarrus	15,083	27,750	42,833	23,489	69,450	92,939
Caldwell	10,047	8,800	18,847		16,500	16,500
Camden						
Carteret		1,850	1,850			
Caswell						
Catawba	5,544	14,520	20,064	3,581	16,705	20,286
Chatham	8,918	1,308	10,226	2,336	2,000	4,336
Cherokee	45,211		45,211	29,459		29,459
Chowan		7,000	7,000		7,700	7,700
Clay	2,458		2,458	7,500		7,500
Cleveland	32,682	4,800	37,482	73,017	4,800	77,817
Columbus		10,300	10,300		12,500	12,500
Craven		47,515	47,515		48,765	48,765
Cumberland		9,500	9,500		16,500	16,500
Currituck						
Dare						
Davidson						
Davie	1,694	5,375	7,069	1,420	19,000	20,420
Duplin		174	174	3,850		3,850
Durham		19,625	19,625		263	263
Edgecombe		36,200	36,200		57,063	57,063
Forsyth		28,840	28,840		31,150	31,150
Franklin	90		90		56,015	56,015
Gaston	1,111	19,400	20,511		14,500	14,500
Gates		270	270	3,365	11,520	14,885
Graham						
Granville	1,799		1,799	12,000		12,000
Greene		420	420		5,420	5,420
Guilford	12,899	189,718	202,617	9,108	145,299	154,407
Halifax	180	25,250	25,430		26,950	26,950
Harnett		1,450	1,450		700	700
Haywood	36,500	4,400	40,900	35,210	3,025	38,235
Henderson	11,295	13,000	24,295	11,880	5,000	16,880
Hertford						
Hyde						
Iredell	240	5,250	5,490	2,063	7,200	9,263
Jackson	76,854		76,854	79,350		79,350
Johnston		16,150	16,150		22,490	22,490
Jones						
Lenoir		2,000	2,000		3,500	3,500
Lincoln	1,841	10,270	12,111		2,199	2,199
McDowell	27,190	4,700	31,890	20,153	3,800	23,953
Macon	47	750	797	2,000		2,000
Madison	37,986		37,986	23,185	625	23,810
Martin						
Mecklenburg	1,183	21,000	22,183	7,462	27,500	34,962
Mitchell	109,466		109,466	89,927		89,927
Montgomery	51,362	390	51,752	62,650		62,650

VALUE OF MINERAL PRODUCTION BY COUNTIES IN NORTH
CAROLINA IN 1904 AND 1905—CONTINUED.

COUNTY.	1904.			1905.		
	MINERAL PRO- DUCTION, INCLUD- ING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.	MINERAL PRO- DUCTION, INCLUD- ING KAOLIN.	CLAY PRODUCTS, EXCEPT KAOLIN.	TOTAL.
Moore	\$ 5,860	\$ 16,400	\$ 22,260	\$ 13,682	\$ 9,954	\$ 23,636
Nash	45	7,800	7,845	2,006	9,000	11,006
New Hanover	12,346	27,125	39,471	34,405	16,500	50,905
Northampton						
Onslow						
Orange	10,617	6,628	17,245	13,340	2,750	16,090
Pamlico						
Pasquotank		10,800	10,800		13,600	13,600
Pender					3,000	3,000
Perquimans					1,330	1,330
Person	15,506		15,506			
Pitt		13,200	13,200		6,950	6,950
Polk	13,738		13,738	25,703		25,703
Randolph	26,236	6,481	32,717		14,093	14,093
Richmond	770		770	2,000		2,000
Robeson		10,788	10,788	1,000	16,888	17,888
Rockingham		39,075	39,075		14,450	14,450
Rowan	127,774	23,000	150,774	334,454	21,800	356,254
Rutherford	5,904	5,700	11,604	34,320	2,556	36,876
Sampson						
Scotland		3,000	3,000	4,450	1,800	6,250
Stanly	17,271		17,271	10,140		10,140
Stokes				3,000	7,000	10,000
Surry	110,466	6,375	116,841	219,883	5,080	224,963
Swain	57,258		57,258	65,212		65,212
Transylvania		750	750	600		600
Tyrrell						
Union	9,902	25,168	35,070	4,977	22,400	27,377
Vance	8,000		8,000	7,150		7,150
Wake	525	31,479	32,004	475	32,634	33,159
Warren	361		361	88,010		88,010
Washington		2,400	2,400		800	800
Watauga				350		350
Wayne		49,625	49,625	3,185	59,563	62,748
Wilkes		8,694	8,694	63	11,320	11,383
Wilson		30,500	30,500		37,000	37,000
Yadkin					838	838
Yancey	35,300		35,300	39,300		39,300
Unknown	1,047		1,047	2,189		2,189
Totals	1,004,393	944,850	1,946,273	1,400,951	1,038,430	2,439,381

The value of the clay products, with the exception of kaolin, which is included with "Other Minerals," is given separately from the rest of the mineral production. As is seen from the above table, the following counties reported no production of mineral of any kind during 1905: Alleghany, Brunswick, Camden, Carteret, Caswell, Currituck, Dare, Gates, Graham, Hertford, Hyde, Jones, Martin, Northampton, Onslow, Pamlico, Person, Sampson, Tyrrell. Of these counties the following reported a production in 1904: Carteret, Gates, and Person. There were 5 counties, Davie, Perquimans, Stokes, Watauga, and Yadkin, which reported a production in 1905, but none in 1904.

Of the 78 counties reporting a mineral production for 1905, there were only 48 counties that reported anything besides clay products. Of the 59 counties reporting a production of clay, 16 counties did not report any other production. There were 20 counties reporting a mineral production which did not include any clay product. Rowan County reported the greatest value for its mineral production, excepting clay products, the value being \$334,454; while Guilford County reported the greatest value of clay products, \$145,299. The county reporting the greatest value for its total mineral production in 1905 was Rowan, with a value of \$356,254. Surry County was second in the value of its total mineral production, which was \$224,963. The lowest value reported by any county for its mineral production was \$263 from Duplin County.

BLACK SAND INVESTIGATIONS.

CONCENTRATING PLANT.

There is now being installed at Chapel Hill, North Carolina, by the United States Geological Survey in coöperation with the North Carolina Geological and Economic Survey, a concentrating plant, whose primary object is a comprehensive investigation of the useful minerals contained in placer deposits, especially those containing what is known as the black sands; and in the sands along the Atlantic seacoast. The plant will also be used to test the pulp obtained by crushing ores from deep mines. Its object is really twofold, that of testing the gravels and ores and also of comparative tests of different concentrators, magnetic separators, etc., in order to determine satisfactory methods for concentrating these sands and separating the different minerals. The plant will be similar to the one erected at Portland, Oregon, during the Lewis and Clark Exposition, and which was maintained there by the United States Geological Survey to the first of October, 1906. Various concentrating tables, such as the Wifley, loaned by the Mines and Smelter Supply Company of Denver, Standard, etc., will be installed; also Wetherill and Blake-Morscher magnetic separators, loaned by the Wetherill Magnetic Separator Company of New York, and the Blake Mining and Milling Company of Denver, respectively; ore crushers, rolls and classifiers, which will permit of the treatment of any of the ores and gravels in order to determine exactly their mineral contents. A storage battery that has been built and loaned by the Electric Storage Battery Company of Philadelphia has also been installed.

The power for the plant will be generated by a gasoline engine loaned by the Fairbanks-Morse Company of Chicago. In connection with the concentrating plant there will be a well-equipped and complete assay laboratory, so that the actual values of gold, silver, platinum, and other metals that the ores may contain can be determined. Many of these gravel deposits and sands contain, besides the precious metals, gold, silver, platinum, such minerals as magnetite, chromite, ilmenite, monazite, garnet, chrysolite, zircon, quartz, etc., which by means of the various machines can be separated not only from the precious metals, but from each other. Some of these minerals have a decided commercial value, and, as they can be separated from each other so as to give an almost pure product of each, they can be obtained in a marketable condition. There is more or less demand for them, depending upon the quantity of each that can be obtained. For the magnetite and ilmenite there may be an opening for use by the various electrical companies, such as the General Electric Company. The chromite, if it occurs in quantity in the sands, would have a decided value for use in the manufacture of chrome steel and chrome salts. Monazite and zircon have already been referred to in this report. The garnet, under certain conditions, would be of value for abrasive purposes.

It has been proved that it is possible to clean quartz sands, such as occur along seashores, so as to obtain a sufficiently pure sand for use in the manufacture of glass.

The method of treatment of the ore will of course vary greatly with the kind of sand. In this work the sands will be grouped into two general classes, (1) sea sands, river sands, and sand-dune material; and (2) low-grade gravels, tailings from dredges and placer workings and richer heavy tailings from the cleanup from sluice-boxes, dredges, etc. Another class of material that will be tested will be pulp from the crushing of various ores.

The samples will be assayed and then screened. The oversize will be examined and the undersize delivered to the concentrating tables, where it will be separated into three portions, concentrates, middlings, and tailings. These separate portions are all carefully examined and the concentrates will be separated on the Wetherill and Blake-Morscher magnetic separators. The Wetherill magnetic separator will separate the concentrates into six portions by five successively increased strengths of current. These minerals group themselves together in separate portions as follows: (1) magnetite, (2) chro-

mite and ilmenite, (3) garnet, (4) olivine, hypersthene, and similar heavy silicates, (5) monazite and (6) non-magnetic residue containing zircon, quartz, iridium, iridosmium, gold and some of the platinum.

It is expected that the concentrating plant will be ready for operation soon after the first of January, and then samples of gravel and concentrates from 100 pounds up to 10 tons can be tested. Before any large samples are sent, however, small 4-pound samples should be forwarded for testing to determine whether they are worthy of further investigation. Those that give indications of containing minerals of economic value in commercial quantity will then be tested in larger quantity to determine the method of separation, etc. The following letter has been sent out regarding the forwarding of 4-pound samples to this office:

DEAR SIR:—The concentrating plant of the United States Geological Survey has just been established at Chapel Hill for testing the heavy sands (so-called black sands) of the Southern Appalachian region. Such sands are collected in the riffles in gold, monazite, and other placer mining. The Geological Survey has, in coöperation with the North Carolina Geological and Economic Survey, undertaken the examination of these heavy sands in order to determine what minerals they contain and if any of these are of economic importance. Tests will also be made as to the best methods of extracting these various minerals such as magnetite, chromite, garnet, monazite, rutile, topaz, zircon, gold, platinum, iridosmium, etc., the separation of some of which may prove to be permanent and profitable industries. The value of gold and silver in all the sands will be determined.

As a preliminary step in this investigation, will you mail to this office, using the accompanying franked envelope (which requires no postage) not more than four (4) pounds of the heavy sands which occur in your placer deposit? This material should be concentrated as well as you can do so before mailing in order to eliminate, as far as possible, the lighter minerals. As far as possible, you should send a record of the clay and the original gravel from which the concentrates were obtained; also exact information as to the name and post-office address of the sender, the name of the mine from which it came and the State, county, city, village, or district in which the deposit is located.

Care should be used to pack the dried sand securely for transmission through the mails, preferably by sewing up the sand in the bag and tying the envelope carefully to the bag. Do not send any samples of sand except where the sand occurs in sufficient quantity so that a ton or a car-load could be obtained, if desired.

Do not send any large samples of sand until instructed to do so by this office.

Yours very truly,

JOSEPH HYDE PRATT,
Director of Concentrating Plant.

There are now over one hundred of these samples on hand, which will be tested shortly and the results obtained will determine the larger samples that will be asked for.

MINING LAWS OF NORTH CAROLINA.

On account of the many inquiries that have been received requesting information relating to the Mining Laws of North Carolina, the laws touching on this subject, as given in the Revisal of 1905, have been collected and are given in the following pages:

MINES.*

I. OPERATORS.

4930. *Lessor not held partner of lessee.* No lessor of property, real or personal, for mining purposes, although the lessor may receive a sum uncertain of the proceeds or net profits, or any other consideration, which, though uncertain at first, may afterwards become certain, shall be held as a partner of the lessee; nor shall any of the legal or equitable relations or liabilities of copartners exist between them, unless it be so stipulated in the contract between the lessor and lessee.

Code, s. 3292; R. C., c. 72; 1830, c. 46.

4931. *Not to employ minors under twelve.* No minor under twelve years of age shall be allowed to work in any mine, and in all cases of minors applying for work the agent of such mine shall see that the provisions of this section are not violated; and the inspector may, when doubt exists as to the age of any person found working in any mine, examine under oath such person and his parents, or other witnesses, as to his age.

1897, c. 251, s. 7.

4933. *To fence unused mines.* All underground entrances to any place not in actual course of working or extension shall be properly fenced across the whole width of such entrance so as to prevent persons from inadvertently entering the same.

1897, c. 251, s. 5.

4935. *Hoisting engines, how operated.* No owner or agent of any mine operated by a shaft or slope shall place in charge of any engine used for lowering into or hoisting out of mines persons employed therein any but experienced, competent, and sober engineers, and no engineer in charge of such engine shall allow any person except such as may be deputed for such purposes by the owner or agent to interfere with it or any part of the machinery, and no person shall interfere or in any way intimidate the engineer in the discharge of his duties, and in no case shall more than two men ride on any cage or car at one time, and no person shall ride upon a loaded cage or car in any shaft or slope.

1897, c. 251, s. 6.

4939. *Notice of opening or changing mines given.* The owner, agent or manager of any mine shall give notice to the inspector in the following cases:

* Chapter 103, Revisal of 1905.

1. When any working is commenced for the purpose of opening a new shaft, slope or mine, to which this chapter applies. 2. When any mine is abandoned, or the working thereof discontinued. 3. When the working of any mine is recommenced after an abandonment or discontinuance for a period exceeding three months. 4. When a squeeze or crush, or any other cause or change, may seem to affect the safety of persons employed in the mine, or when fire occurs.

1897, c. 251, s. 7.

ACCIDENTS IN MINES.

4940. *Accidents; notice of, given.* The owner, agent, or manager of every mine shall, within twenty-four hours next after any accident or explosion, whereby loss of life or personal injury may have been occasioned, send notice, in writing, by mail or otherwise, to the inspector, and shall specify in such notice the character and cause of the accident, and the name or names of the persons killed, and injured, with the extent and nature of the injuries sustained. When any personal injury of which notice is required to be sent under this section results in the death of the person injured, notice in writing shall be sent to the inspector within twenty-four hours after such death comes to the knowledge of the owner, agent, or manager, and when such loss of life occurs in any mine by explosion, or accident, or results from personal injuries so received, the owner, agent, or manager of such mine shall notify the coroner of the county in which such mine is situated, and the coroner shall hold an inquest upon the body of the person whose death has been thus caused, and inquire carefully into the cause thereof, and return a copy of the finding of the jury and all the testimony to the inspector.

1897, c. 251, s. 6.

4941. *Report to inspector.* The owner, lessee or agent in charge of any mine, any limestone quarry, or who is engaged in mining or producing any mineral whatsoever in this State, shall, on or before the thirtieth day of November in every year, send to the office of the inspector upon blanks to be furnished by him a correct return, specifying with respect to the year ending on the preceding first day of October the quantity of coal, iron ore, fire-clay, limestone, or other mineral product of such mine or quarry, and the number of persons ordinarily employed in or about such mine or quarry, below and above ground, distinguishing the persons and labor below ground and above ground.

1897, c. 251, s. 3.

4942. *Liable for injuries.* For any injury to person or property occasioned by any wilful violation of this chapter, or any wilful failure to comply with its provisions, by any owner, agent or manager of the mine, a right of action shall accrue to the party injured for any damage he may have sustained thereby; and in any case of loss of life by reason of such wilful neglect or failure aforesaid a right of action shall accrue to the personal representative of the deceased, as in other actions for wrongful death.

1897, c. 251, s. 6.

II. INSPECTOR.

4943. *Commissioner of Labor and Printing is, ex officio.* The Commissioner of Labor and Printing shall perform the duties of mine inspector as provided in this chapter.*

1897, c. 251, s. 1.

* See Section 3910 of Chapter 84 of Revisal of 1905, Vol. II.

4944. *To examine mines.* It shall be the duty of the inspector to examine all the mines in the State as often as possible to see that all the provisions and requirements of this chapter are strictly observed and carried out; he shall particularly examine the works and machinery belonging to any mine, examine into the state and conditions of the mines as to ventilation, circulation, and condition of air, drainage, and general security.

1897, c. 251, s. 2.

4945. *May enter to make examinations.* For the purpose of making the inspection and examinations provided for in this chapter, the inspector shall have the right to enter any mine at all reasonable times, by night or by day, but in such manner as shall not unnecessarily obstruct the working of the mine; and the owner or agent of such mine is hereby required to furnish the means necessary for such entry and inspection; the inspection and examination herein provided for shall extend to fire-clay, iron ore, and other mines, as well as coal mines.

1897, c. 251, s. 2.

4946. *Death by accident investigated.* Upon receiving notice of any death resulting from accident it shall be the duty of the inspector to go himself, or to send a representative, at once to the mine in which said death occurred, and inquire into the cause of the same, and to make a written report fully setting forth the condition of that part of the mine where such death occurred and the cause which led to the same; which report shall be filed by the inspector in his office as a matter of record, and for future reference.

1897, c. 251, s. 6.

4947. *Keep record of examinations.* He shall make a record of all examinations of mines, showing the date when examination made, the condition in which the mines are found, the extent to which the laws relating to mines and mining are observed or violated, the progress made in the improvements and security of life and health sought to be secured by the provisions of this chapter, number of accidents, injuries received or deaths in or about the mines, the number of mines in the State, the number of persons employed in or about each mine, together with all such other facts and information of public interest, concerning the condition of mines, development and progress of mining in the State as he may think useful and proper, which record shall be filed in the office of the inspector, and as much thereof as may be of public interest to be included in his annual report.

1897, c. 251, s. 2.

4948. *Preserve papers.* He shall keep in his office and carefully preserve all maps, surveys, and other reports and papers required by law to be filed with him, and so arrange and preserve the same as shall make them a permanent record of ready, convenient, and connected reference.

1897, c. 251, s. 3.

4949. *To enforce law; counsel furnished.* In case of any controversy or disagreement between the inspector and the owner or operator of any mine or the persons working therein, or in case of conditions or emergencies requiring counsel, the inspector may call on the Governor for such assistance and counsel as may be necessary. Should the inspector find any of the provisions of this chapter violated or not complied with by any owner, lessee or agent in charge, unless the same is within a reasonable time rectified, and the provisions of this chapter fully com-

plied with, he shall institute an action in the name of the State to compel the compliance therewith. The inspector shall exercise a sound discretion in the enforcement of this chapter.

1897, c. 251, s. 2.

4950. *Enjoin operations when law violated.* On application of the inspector, after suit brought as directed in the preceding section, any court of competent jurisdiction may enjoin or restrain the owner or agent from working or operating such mine until it is made to conform to the provisions of this chapter; and such remedy shall be cumulative, and shall not take the place of or affect any other proceedings against such owner or agent authorized by law for the matter complained of in such action.

1897, c. 251, s. 7.

4951. *Report to Governor.* The inspector shall annually make report to the governor of all his proceedings, the condition and operation of the different mines of the State, and the number of mines and the number of persons employed in or about such mines, the amount of coal, iron ore, limestone, fire-clay or other mineral mined in this State; and he shall enumerate all accidents in or about the mines, and the manner in which they occurred, and give all such other information as he thinks useful and proper, and make such suggestions as he deems important relative to mines and mining, and any legislation that may be necessary on the subject for the better preservation of the life and health of those engaged in such industry.

1897, c. 251, s. 3.

4952. *To what applicable.* The provisions of this chapter shall not apply to or affect any mine in which not more than ten men are employed at the same time; but the inspector shall at all times have free ingress to such mines for the purpose of examination, and shall direct and enforce any regulation in accordance with the provisions of this chapter that he may deem necessary for the safety of the health and lives of the miners employed therein.

1897, c. 251, s. 8.

III. WATERWAYS OBTAINED.

4953. *Water and drainage rights, how obtained.* Any person or body corporate engaged or about to engage in mining, who may find it necessary for the furtherance of his operations to convey water either to or from his mine or mines over the lands of any other person or persons, may make application by petition in writing to the clerk of the superior court of the county in which the lands to be affected or the greater part are situate, for the right so to convey such water. The owner of the lands to be affected shall be made a party defendant and the proceeding shall be conducted as other special proceedings.

Code, ss. 3293, 3294, 3300; 1871-2, c. 158, ss. 1. 3.

4954. *The petition, what to contain.* The petition shall specify the lands to be affected, the name of the owner of such lands, and the character of the ditch or drain intended to be made.

Code, s. 3294; 1871-2, c. 158, s. 3.

4955. *Appraisers; appointment, duties and pay of.* Upon the hearing of the petition, if the prayer thereof be granted, the clerk shall appoint three disinterested persons, qualified to act as jurors, and not connected either by blood or marriage

with the parties, appraisers to assess the damage, if any, that will accrue to the lands by the contemplated work, and shall issue a notice to them to meet upon the premises at a day specified, not to exceed ten days from the date of such notice. The appraisers having met, shall take an oath before some officer qualified to administer oaths to faithfully perform their duty and to do impartial justice in the case, and shall then examine all the lands in any way to be affected by such work, and assess the damage thereto, and make report thereof under their hands and seals to the clerk from whom the notice issued.

Code, ss. 3295, 3296, 3299; 1871-2, c. 158, ss. 4, 5, 9.

4956. *Confirmation of report; payment of damages; rights of petitioner.* After the filing of the report and confirmation thereof by the clerk, who shall have power to confirm or, for good cause, set aside the same, the petitioner shall have full right and power to enter upon such lands and make such ditches, drains or other necessary work: *Provided*, he has first paid or tendered the damages, assessed as above, to the owner of such lands or his known and recognized agent, if he be a resident of this State, or have such agent in this State. If the owner be a non-resident and have no agent in this State, the amount so assessed shall be paid by the petitioner into the office of the Clerk of the Superior Court of the county for the use of such owner.

Code, s. 3297; 1871-2, c. 158, s. 7.

4957. *Registration of report.* The petitioner, or any other person interested, may have the report of the appraisers registered upon the certificate of the Clerk, and shall pay the Register a fee of twenty-five cents therefor.

Code, s. 3298; 1871-2, c. 158, s. 8.

SPECIAL LAWS RELATING TO COAL MINES.*

4932. *To furnish timber.* The owner, agent or operator of every coal mine shall keep a supply of timber constantly on hand, and shall deliver the same to the working place of the miner, and no miner shall be held responsible for accident which may occur in the mine where the provisions of this section have not been complied with by the owner, agent or operator thereof, resulting directly from the failure to deliver such timber.

1897, c. 251, s. 8.

4934. *Means of ingress and egress provided.* No owner or agent of any coal mine worked by shaft shall permit any person to work therein unless there are, to every seam of coal worked in such mine, at least two separate outlets, separated by natural strata of not less than one hundred feet in breadth, by which shafts or outlets distinct means of ingress and egress are always available to the persons employed in the mine; but it is not necessary for the two outlets to belong to the same mine if the persons employed therein have safe, ready and available means of ingress or egress by not less than two openings. This section shall not apply to opening a new mine while being worked for the purpose of making communications between said two outlets, so long as not more than twenty persons are employed at one time in such mine; neither shall it apply to any mine or part of a mine in which the second outlet has been rendered unavailable by reason of the final robbing of pillars previous to abandonment, as long as not more than twenty persons are employed therein at any one time. The cage or cages and other

* Part of Chapter 103, Revision of 1905.

means of egress shall at all times be available for the persons employed when there is no second outlet. The escapement shafts shall be fitted with safe and available appliances, which shall always be kept in a safe condition, by which the persons employed in the mine may readily escape in case an accident occurs; and in no case shall an air-shaft with a ventilating furnace at the bottom be construed to be an escapement shaft within the meaning of this section. To all other coal mines, whether slopes or drifts, two such openings or outlets must be provided within twelve months after shipments of coal have commenced from such mine; and in case such outlets are not provided as herein stipulated, it shall not be lawful for the agent or owner of such slope or drift to permit more than ten persons to work therein at any one time.

1897, c. 251, s. 4.

4936. *Ventilation.* The owner or agent of any coal mine, whether shaft, slope or drift, shall provide and maintain for every such mine an amount of ventilation of not less than one hundred cubic feet per minute per person employed in such mine, which shall be circulated and distributed throughout the mine in such a manner as to dilute, render harmless and expel the poisonous and noxious gases from each and every working place in the mine, and no working place shall be driven more than sixty feet in advance of a break-through or airway, and all break-throughs or airways, except those last made near the working places of the mine, shall be closed up by brattice trap-doors, or otherwise, so that the currents of air in circulation in the mine may spread to the interior of the mine when the persons employed in such mine are at work, and all mines governed by this chapter shall be provided with artificial means of producing ventilation, such as forcing or suction fans, exhaust steam furnaces, or other contrivances of such capacity and power as to produce and maintain an abundant supply of air, and all mines generating fire-damp shall be kept free from standing gas.

1897, c. 251, s. 5.

4937. *Daily examinations; safety lamps.* Every working place shall be examined every morning with a safety lamp by a competent person before any workmen are allowed to enter the mine. All safety lamps used in examining mines, or for working therein, shall be the property of the operator of the mine, and a competent person shall be appointed, who shall examine every safety lamp before it is taken into the workings for use, and ascertain it to be clean, safe and securely locked, and safety lamps shall not be used until they have been so examined and found safe and clean and securely locked, unless permission be first given by the mine foreman to have the lamps used unlocked. No one, except the duly authorized person, shall have in his possession a key, or any other contrivance, for the purpose of unlocking any safety lamp in any mine where locked lamps are used. No matches or any other apparatus for striking lamps shall be taken into any mines, or parts thereof, except under the direction of the mine foreman.

1897, c. 251, ss. 5, 6.

4938. *Report of ventilation.* The mine foreman shall measure the ventilation at least once a week, at the inlet and outlet, and also at or near the face of all the entries, and the measurement of air so made shall be noted on blanks furnished by the inspector; and on the first day of each month the mine boss of each mine shall sign one of such blanks, properly filled with the said actual measurement, and present the same to the inspector.

1897, c. 251, s. 6.

GENERAL LAWS RELATING TO MINING.

3380. *Drains, obstructing, when necessary for mining.* If any person shall obstruct any drain or ditch constructed under the provisions of the law in regard to mines, he shall be guilty of a misdemeanor.

Code, s. 3301; 1871-2, c. 158, s. 12.

3797. *Mines.* If any person shall knowingly violate any of the provisions of the law relating to mines or shall do anything whereby the life or health of persons or the security of any mine and machinery is endangered, or if any miner or other person employed in any mine governed by the statutes shall intentionally or wilfully neglect or refuse to securely prop the roof of any working place under his control, or neglect or refuse to obey any orders given by the superintendent of a mine in relation to the security of a mine in the part thereof where he is at work and for fifteen feet back of his working place, or if any miner, workman or other person shall knowingly injure any water-guage, barometer, air-course or brattice, or shall obstruct or throw open any airways, or shall handle or disturb any part of the machinery of the hoisting engine or signaling apparatus or wire connected therewith, or air-pipes or fittings, open a door of the mine, and not have the same closed again, whereby danger is produced either to the mine or those that work therein, or shall enter any part of the mine against caution, or shall disobey any order given in pursuance of law, or shall do any wilful act whereby the lives and health of the persons working in the mines or the security of the mine or the machinery thereof is endangered, or if the person having charge of a mine when ever loss of life occurs by accident connected with the machinery of such mine or by explosion shall neglect or refuse to give notice thereof forthwith by mail or otherwise to the inspector and to the coroner of the county in which such mine is situated, or if any such coroner shall neglect or refuse to hold an inquest upon the body of the person whose death has been thus caused, and return a copy of his findings and a copy of all the testimony to the inspector, he shall be guilty of a misdemeanor, and upon conviction fined not less than fifty dollars or imprisoned in the county jail not more than thirty days, or both.

1897, c. 251, s. 8.

2000. *Mining and timber land leases.* If in a lease of land for mining, or of timbered land for the purpose of manufacturing the timber into goods, rent shall be reserved, and if it shall be agreed in the lease that the minerals, timber or goods, or any portion thereof, shall not be removed until the payment of the rent, in such case the lessor shall have the rights and be entitled to the remedy given by this chapter.*

Code, s. 1763; 1868-9, c. 156, s. 16.

MINERAL INTEREST IN LAND.

2488. *Separate partition of surface and mineral interests.* When the title to the mineral interests in any land has become separated from the surface in ownership the tenants in common of such mineral interests may have partition of the same, distinct from the surface, and without joining as parties the owner or owners of the surface; and the tenants in common of the surface may have partition of the same in manner provided by law, distinct from the mineral interests and without joining as parties the owner or owners of the mineral interests. And in all

* Section from Chapter 46, on Landlord, etc.

instances where the mineral interests and surface interests have thus become separated in ownership, the owner or owners of the mineral interests shall not be compelled to join in a partition of the surface interests, nor shall the owner or owners of the surface interests be compelled to join in a partition of the mineral interests, nor shall the rights of either owner be prejudiced by a partition of the other interests.

1905, c. 90.

2507. *Sale of mineral interests.* In case of the partition of mineral interests, in all instances where it shall be made to appear to the Court that it would be for the best interest of the tenants in common of such interests to have the same sold, or if actual partition of the same cannot be had without injury to some or all of such tenants in common, then it shall be lawful for and the duty of the Court to order a sale of such mineral interests and a division of the proceeds as the interests of the parties may appear.

1905, c. 90, s. 2.

LAWS RELATING TO PHOSPHATE ROCK.

1751. *Phosphate rock under navigable waters, when entered.* Any resident of this State who shall make affidavit before the Clerk of the Superior Court of any county through which such navigable stream may flow, that he has discovered in any navigable stream or waters of this State any phosphate rock or phosphate deposit therein, shall have authority and power to enter under the entry laws of this State so much of the bed of any such navigable stream or waters as shall not exceed in any one entry two miles in length up the middle of any such stream or water for the purpose of digging, mining or removing any such deposit or rock.

1891, c. 476.

1752. *How grant obtained; term; royalty.* Upon such affidavit being filed with the entry-taker, and upon a survey and plot being made of such entry by the county surveyor, as is now required by law in cases of entry of land, being made and certified to the Secretary of State with a copy of such affidavit and entry so made, the said Secretary of State shall issue a patent or grant to the said person, his heirs or assigns, for a term of twenty-five years for such land, with the proviso and condition inserted therein that the grantee therein shall pay to the Treasurer of the State at the end of every three months a royalty of one dollar per ton for each and every ton of the crude phosphate rock or deposit mined, dug or removed.

1891, c. 476, s. 2.

1753. *Exclusive right to mine; bond for royalty.* Such grantee, his heirs or assigns, shall have the exclusive right to mine, dig or remove any such phosphate rock or deposit for the term of twenty-five years from the date of said patent upon paying the said royalty of one dollar specified in said patent: *Provided, however,* that as a condition precedent to the granting of any such patent each such company or person making any such entry shall enter into bond with sufficient security in the penal sum of five thousand dollars, conditioned for the making of faithful and true returns to the Treasurer of the State of the number of tons of phosphate rock and phosphate deposit so dug, mined or removed, at the end of every month, and the punctual payment to the said Treasurer of the royalty of one dollar per ton upon each and every ton of the crude rock, without being steamed or

dried, at the end of every three months, and the said bond and sureties shall be subject to the approval now required by law for the bonds of State officers.

1891, c. 476, s. 3.

1754. *Navigation not obstructed by grantee.* No grant issued under the provisions of this subchapter shall confer upon the person receiving the same the right to obstruct the navigation of any such stream or water, nor confer upon any such person or his assigns any other right than that granted to take, mine or dig phosphate rock or deposit therefrom.

1891, c. 476, s. 4.

1755. *Fees for issuing grant for phosphate beds.* No fee or cost shall be charged or collected by the Secretary of State of any person or corporation receiving any patent or grant under this subchapter, except the fee allowed by law to the said Secretary of State for issuing a patent under the entry laws of the State.

1891, c. 476, s. 5.

1756. *Failure to operate for two years vacates grant.* Any person, company or corporation who shall fail to dig, mine or remove phosphate rock or deposit from any such stream or water to which he or it may be entitled under any patent or grant issued under the provisions of this subchapter for the period of two years from the date of said patent, or, after beginning digging, mining or removing the same, shall fail to continue to so dig, mine or remove the same for the period of two years, shall forfeit any and all rights therein granted, and said territory shall immediately thereupon become subject to entry under the provisions of this subchapter without making the affidavit of the discovery of any such deposits or rocks.

1891, c. 476, s. 6.

1757. *May be mined without grant, how.* Any person or corporation resident of this State shall have the right to mine, dig or remove phosphate rock or deposits from any of the navigable streams or waters in this State to which no exclusive patent or grant may have been issued, upon such person or corporation first entering into bond in the penal sum of five thousand dollars, payable to the Treasurer of the State, for the payment of the same royalty, in the same manner and under the same regulations as are prescribed in section one thousand seven hundred and fifty-three; but nothing in this section shall be construed to give to any such person or corporation any exclusive franchise or privilege to dig, mine or remove any such phosphate rock or deposit from any stream or water of this State.

1891, c. 476, s. 7.

3744. *Phosphate rock in rivers.* If any person shall dig, mine or remove any phosphate rock or deposit from any of the navigable waters of the State, except for the purpose of prospecting and discovering as allowed by law, he shall be guilty of a misdemeanor, and shall also forfeit and pay ten dollars per ton for every ton of phosphate rock or deposit so mined, dug, or removed, one-half to the use of the State and the other one-half to go to the informer.

MARL BEDS.

3796. *Marl beds, failure to enclose.* If any person shall open any marl bed without surrounding it with a lawful fence, he shall be guilty of a misdemeanor, and upon conviction shall be fined not exceeding fifty dollars or imprisoned not exceeding thirty days: *Provided*, this shall not apply to any person whose marl bed is enclosed inside his own enclosure.

PUBLICATIONS
OF THE
NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Postage 10 cents.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Postage 10 cents.*
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